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DoD Corrosion Prevention and Control Program

Demonstration of a Nanomaterial-Modified Primer for Use in Corrosion-Inhibiting Coating Systems

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Final report

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Abstract: Above-ground steel fuel tanks, some as large as 1 million gallons, are the main fuel supply for central energy plants and aviation support throughout the Department of Defense (DoD). These tanks and their associated pipelines are aging and many need remediation before leaks or catastrophic failures occur. This project evaluated an emerging coating technology for steel tanks and implemented the technology at Fort Bragg, NC, on a fuel oil storage tank.

For conventional zinc-rich primer to be effective, the metallic zinc dust pigment particles must be heavily loaded in the coating binder (65–95%) so that zinc particles are in contact with each other for electrical conductivity. This high loading can be problematic during coating application/removal due to zinc metal's heavy weight and the traces of lead it normally contains. The coating used in this project is a technically advanced primer additive that uses galvanically inactive, electrically conductive fullerene carbon nanotubes in conjunction with a much lower percentage of the metallic zinc powder (~30%) to produce the enhanced galvanic reactivity with the steel substrate. The reduced content of the zinc pigment to resin/binder volume ratio also improves the coating integrity and application.

Executive Summary

This Office of the Secretary of Defense Corrosion Prevention and Control project demonstrated and validated the successful use of a modified metallic zinc-containing primer on exterior surfaces of a steel fuel tank and associated piping. The primer contained technically advanced additives consisting of galvanically inactive, electrically conductive fullerene carbon nanotubes (CNTs). This CNT/zinc hybrid primer formulation allowed for reducing the high metallic zinc pigment loading (65–95%) of a traditional zinc-rich primer to provide for better coating application and performance. The hybrid primer (10–30% metallic zinc powder) provides at a minimum the same galvanic protection to scratched or damaged areas as does the traditional zinc-rich primer. If a void in the paint system (i.e., a holiday) develops, corrosion normally initiates at that point. However, when using the CNT/zinc hybrid primer, if a holiday develops, the bare area is still protected by the reduced-load metallic zinc coating that continues to function as a sacrificial anode with increased performance due to the conductivity of the CNTs. Studies have demonstrated that traditional zinc-rich primer sacrificial coatings can provide the best protection to steel for 20–50 years or more. This demonstration/validation (dem/val) project supports the claim that the CNT/zinc hybrid primer can provide the same level of corrosion protection and be easier to apply when compared to traditional metallic zinc-rich primer systems.

During project testing, Mandaree Enterprise Corporation conducted a review of the Material Safety Data Sheet (MSDS) and available industry/academia carbon nanotube-related literature. As the use of CNT in various applications is relatively new technology, a complete determination of the toxicity of carbon nanotubes has not been completely established. The MSDS review did not reflect any unusual risks associated with the CNT containing primer. However, other carbon nanotube reference material reviewed indicate that, in animal studies under certain conditions, nanotubes may be able to cross biological membrane barriers, which suggests that if ingested, inhaled, or otherwise entering the body, they may induce harmful effects such as inflammatory and fibrotic reactions [1, 2, 3, 4, 5]. Researchers will continue to investigate the biological effects of exposure to carbon nanotubes and nanofibers, but in

the meantime, precautionary measures are advised during the handling of dry materials in the coating manufacturing process. Once these dry nanotubes are dispersed in the liquid epoxy resin components, they are unlikely to be released by any downstream processing, including coating application, exposure to weather, and paint removal by abrasive blasting or other means. This report documents the materials and methodologies used for testing and application of the new coating systems on the fuel storage tank and associated piping at Fort Bragg, NC.

The project metrics were met or exceeded. This project has shown that the installation method with improved corrosion resistant coatings will provide the DoD with a means to cost effectively rehabilitate the outer metal surfaces of structurally sound fuel tanks and their associated piping. These coatings should extend the service life of all steel fuel and water storage tanks in all environments.

Further studies may be necessary to develop the most effective combined corrosion prevention rehabilitation package for many other metal structures. Additional studies should be completed to determine any adverse bio-environmental effects that may occur by long-term exposure to the CNT/zinc hybrid primer or other materials containing the CNT.

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Preface

This demonstration/validation project was performed for the Office of the Secretary of Defense (OSD), Corrosion Policy and Oversight, under Department of Defense (DoD) Corrosion Prevention and Control (CPC) Program project FY 07-AR-19, "Application of Innovative Coating System on the Exterior of a Fuel Oil Tank at Fort Bragg, NC"; Military Interdepartmental Purchase Request MIPR7CCORB1019, dated 21 November 2006 The proponent was the US Army Office of the Assistant Chief of Staff for Installation Management (ACSIM), and the stakeholder was the US Army Installation Management Command (IMCOM). The technical monitors were Daniel J. Dunmire (OUSD(AT&L)), Bernie Rodriguez (IMPW-E), and Valerie D. Hines (DAIM-ODF).

The work was performed by the Materials and Structures Branch (CF-M), Facilities Division (CF), US Army Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL). Mandaree Enterprise Corporation (MEC), Warner Robins, GA, provided project management and onsite material and process assessments. The MEC principal subcontractor for all coating applications was Adam Brown, J&W of North Carolina. The test coatings were provided by Todd Hawkins of TeslaNano Coatings Limited. At the time this report was published, Vicki L. Van Blaricum was Chief, CF-M, L. Michael Golish was Chief, CF, and the Technical Director for Installations was Martin J. Savoie (CEERD-CV-ZT). The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Ilker Adiguzel.

The following Fort Bragg personnel are gratefully acknowledged for their support and assistance in this project: Russell Hayes –Mechanical Engineer Department of Public Works; Gene Foster – Field Service Leader, Honeywell Building Solutions; and all personnel of the heating plant at Fort Bragg.

COL Kevin J. Wilson was the Commander and Executive Director of ERDC, and Dr. Jeffery P. Holland was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
degrees Fahrenheit	(F-32)/1.8	degrees Celsius
feet	0.3048	meters
gallons (US liquid)	3.785412 E-03	cubic meters
inches	0.0254	meters
mils	0.0254	millimeters
square feet	0.09290304	square meters

1 Introduction

1.1 Problem statement

Coatings have been a principal element of corrosion protection for steel structures for many years. The best corrosion-inhibiting primers for steel has been shown to contain high volumes of metallic zinc powder (65–95%) that galvanically protects the steel between the cathodic substrate and anodic sacrificial zinc. However, these coatings are so heavily loaded with the metallic zinc pigment that it reduces the integrity of the coating film as compared with other primer coatings. Industry has developed an innovative way to reduce the metallic zinc pigment powder by replacing much of metallic zinc powder (10–30%) with an additive of galvanically inactive, electrically conductive carbon nanotubes (CNTs).

This CNT additive can be adapted to a wide variety of binder systems. The additive is typically loaded at appreciably low levels when compared with traditional zinc-rich primers. The CNT screening factors have shown promising test results with either aluminum or zinc sacrificial metal particles.

The new coating used in this demonstration/validation (dem/val) project is designed to improve the corrosion protection on an above-ground steel fuel tank and associated piping at Fort Bragg, NC. The storage tank shows signs of physical deterioration due to age and requires remediation. The US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) estimates that 25 other Army installations have similar problems with above-ground steel storage tanks. There are further indicators of similar problems at virtually all Department of Defense (DoD) installations.

As a consequence, the need is urgent to evaluate emerging innovative protective coating technologies for fuel and water storage tanks as part of the DoD Corrosion Prevention and Control (CPC) Program. This coatings research is part of an ERDC-CERL Paint Technology Center project to develop a CNT additive for use in zinc-rich primer coating systems.

1.2 Objective

The objective of this demonstration was to prepare the steel tank surface through abrasive blasting, apply the subject coating system, and monitor its performance over time.

1.3 Approach

1.3.1 Project planning

In accordance with the Delivery Order Statement of Work (SOW), Mandaree Enterprise Corporation (MEC) provided the majority of the following project documentation for review and approval at the Pre-Construction Meeting held at Fort Bragg on 8 October 2008, the remainder was provided shortly thereafter:

1. Work Plan (Appendix A)
2. Health and Safety Plan
3. Toxic Characteristic Leaching Procedure (TCLP) Report (Appendix B)
4. Containment System Design (Appendix C)
5. Coatings Qualification Test Reports (Appendix D)
6. Coating System Manufacturer's Instructions (Appendix E)
7. Certification of Sealant Conformance to Specifications
8. Joint Sealant Manufacturer's Instructions.

All plans and documents submitted were determined to be in accordance with EM 385-1-1 and National Fire Protection Association 241 as required by the contract SOW. The approved documents are included in Appendices A–H of this report.

Also as required by the SOW, MEC and ERDC-CERL conducted a review and discussed the coating technology evaluation of the above-ground 82d Airborne Division Heating Plant fuel oil tank #2 (measuring 33.5 ft in diameter by 34 ft high (vertical) and associated piping. After completing the review, MEC and ERDC-CERL discussed the evaluation of tank #2. The processes discussed were to:

- abrasive-blast the tank surfaces to bare metal, near white metal finish (SSPC-10)
- prime the prepared metal surfaces with an epoxy primer modified to contain both metallic zinc powder and the CNTs

- apply an intermediate epoxy primer over the base primer
- apply a liquid polymeric coating as a topcoat

In addition, the same processes would be applied to the associated steel piping within the fuel tank containment area.

1.3.2 Surface preparation

Substrate surface preparation was conducted in accordance with project requirements and appropriate industry standards for the coating system to be applied. In accordance with Delivery Order requirements for this project, the Heating Plant tank #2 substrate was prepared with abrasive blasting to remove existing paint and contamination per Unified Facilities Guide Specifications (UFGS) 02 82 33.13 20, "Removal/Control And Disposal of Paint With Lead" (April 2006), and both 15A NCAC 02D.0521 and 15A NCAC 02D.0541[1]. Analysis of the existing paint revealed no lead content. The blasted surfaces were inspected for compliance with the requirements of Society for Protective Coatings (SSPC) Standard VIS 1 (near-white metal). Surfaces that did not meet SSPC VIS 1 requirements after inspection were re-blasted and re-inspected until compliance was achieved. Storage and disposal of the wastes created by the abrasive blasting were conducted in compliance with state and federal solid and hazardous waste regulations and all permits and manifests related to waste management were obtained. MEC's coating subcontractor controlled the waste generated onsite during operations by establishing a Hazardous Waste Accumulation Site (HWAS) with a secured onsite container. The HWAS location was approved by the Environmental Compliance Branch at Fort Bragg. MEC met with the Fort Bragg Directorate of Public Works (DPW), Environmental Compliance Branch, Hazardous Waste Office prior to starting abrasive blasting operations, to provide assurance of compliance with all regulations. At the conclusion of operations, the MEC subcontractor removed all waste materials from the site and disposed of them at an appropriate licensed off-base facility.

[1] Title 15 A, North Carolina Administrative Code (NCAC) 02D.0521, "Control of Visible Emissions"; and NCAC 02D..0541, "Control of Emissions from Abrasive Blasting."

1.3.3 Coating process

Coating application also was conducted in compliance with project requirements, including industry standards and the product manufacturer's published instructions and specifications. After proper surface preparation was completed, the coating application contractor applied the CNT/zinc hybrid primer on the surface of the Heating Plant tank #2. Spraying was coordinated with abrasive blasting to ensure that no more than 8 hours had expired between the two processes for optimum adhesion of the primer coat to the prepared substrate. The coatings were applied in accordance with SSPC PA 1. The Military Specification MIL-DTL-24441/19 (modified per section 09 97 13.27) CNT/zinc hybrid primer coating was applied to an average thickness of 0.002 in. with no more than 0.oo5 in. at any measurement site. The CNT/zinc hybrid primer was sprayed in two half-lapped passes oriented at right angles to each other. The intermediate epoxy primer MIL-DTL-24441/31 stripe coat was then applied within the specified recoat window followed by the application of a full coat of intermediate primer to an average thickness of 0.003 in. with no more than 0.0005 in. at any site. Finally, the topcoat of MIL-PRF-85285 High Solids Polyurethane coating was applied to a thickness of 0.002 to 0.003 in. to conform to Fort Bragg's color requirements for providing an extended service life for the paint system.

1.3.4 Coating evaluation

Twelve mild steel coating test coupons (3 by 9 by 0.125 in.) were prepared and mounted in a test rack at the heating plant for environment exposure per ASTM D1040. Each coupon was prepared and coated in compliance with the requirements of the SOW. Six coupons were abrasive blasted and coated with the CNT/zinc hybrid primer, intermediate primer, and topcoat system. Six coupons were delivered to ERDC-CERL and six were deployed on a test rack at the Fort Bragg Power Plant for atmospheric exposure.

1.3.5 Overall project evaluation

The processes and materials for each selected coating system were evaluated and documented with respect to the application for which they were intended. Material, labor, and other associated process cost data were also documented to augment the technical data in order to provide a comprehensive evaluation of the technology and a basis for calculating the return on investment. Lessons learned were documented for prospective users.

2 Technical Investigation

2.1 Project overview

Fort Bragg has two large above-ground steel fuel tanks and associated piping used for Heating Plant fuel oil storage. These tanks are showing signs of age and corrosion; therefore, the tanks need remediation before they start leaking. Tank #1 was recoated under a previous project and tank #2 is the dem/val target for this project. The project calls for abrasive blast stripping, priming with CNT/zinc hybrid primer, applying an intermediate primer, and then top coating the tank. The steel fuel tank, which is shown in Figure 1, measures 33.5 ft in diameter by 34 ft high.

Additionally, this project directed that the surface preparation and coating be applied to associated piping within the containment area, which required special preparation. The severely corroded condition of piping is shown in Figure 2 and Figure 3.

Figure 1. Fort Bragg fuel oil tank #2 with piping (foreground).

Figure 2. Corroded fuel tank piping with electrical conduit.

Figure 3. Corroded fuel tank piping.

2.1.1 Specifications

2.1.1.1 Abrasive blast

Material Description: Mobile Abrasives. "Black Blast," MIL-A-22262A (SH) /Amendment-2.
Technical data sheet and MSDS in Appendix G.
Surface Quality Requirement: SSPC-SP 10 (NACE 1), near white metal.
Surface Profile Requirement: 0.002–0.003 in.

2.1.1.2 Zinc-rich primer

Material description: Epoxy polyamide, MIL-DTL-24441/19 (Formula 159, Type III), except that component B shall be formulated with a zinc dust replacement of 10–30% of CNT and an undetermined percentage of the metallic zinc dust.
Technical data sheet and MSDS in Appendix E.
DFT Coating Thickness Requirement: 0.002–0.005 in.
Coating Thickness Gage: Elcometer 456, Type II Appendix H

2.1.1.3 Intermediate primer

Material description: Epoxy Intermediate Coat MIL-DTL-24441/31 Formula 152 Type IV (White (Tinted)
Technical data sheets and MSDS in Appendix E.
DFT Coating Thickness Requirements: 0.003–0.005 in.
Coating Thickness Gage: Elcometer 456, Type II Appendix H

2.1.1.4 Top coat

Material description: Polyurethane Topcoat MIL-PRF-85285 Type II
Technical data sheets and MSDS in Appendix E.
DFT Coating Thickness Requirements: 0.002–0.003 in.
Coating Thickness Gage: Elcometer 456, Type II Appendix H

2.1.2 Application design details

The coating system was designed to protect steel in corrosive environments. The demonstration was intended to assess the coating system's application to high-value facility infrastructure. The first step involved determining if lead-based coatings were used on the tanks. Analysis of the coatings on the tanks determined them to be lead free. The application design included a containment system for the abrasive blasting operation

and scaffolding structure along with proper disposal. Environmental controls were managed to ensure proper temperatures were maintained during coating application.

2.2 Application of the technology

2.2.1 Fuel oil tank #2

Work to erect the containment system began in October 2008 and consisted of erection of scaffolding and a tarp enclosure around the tank for containment of the blast and coating processes (Figure 4 and Figure 5).

Fuel oil tank #2 was abrasive-blasted to remove the existing coating and prepare the surface for repainting. The tank was recoated during November and December 2008; final work on piping was completed in January 2009.

Figure 4. Scaffolding erected around fuel oil tank #2.

Figure 5. Scaffolding fully contained with environmental controls in place.

The abrasive blasting activities were coordinated so that bare metal would be exposed for no more than 8 hours between blasting and coating, as required by UFGS Section 09 97 13.27 and SSPC-SP 10 - NACE No. 2 - Near White Blast Cleaning. An aggressive surface profile with sharp tooth is necessary for excellent coating adhesion to the tank substrate. The surface profile was measured as part of the quality assurance (QA) inspection process using Elcometer 224 Digital Surface Profile Gauge. Accordingly, the tank surface was visually inspected for SSPC-VIS 1 continuously and profile measurements were conducted approximately every 100 SF to ensure proper surface preparation (cleanliness and profile depth) had been achieved. Figure 6 and Figure 7 show examples of the prepared surfaces.

Figure 6. Abrasive blast-cleaned tank surface.

Figure 7. Abrasive blast-cleaned tank ladder.

The CNT/zinc hybrid primer coating was applied using at least two half-lapped passes at right angles to achieve the required thickness. Primer coating thickness was measured during application using an Elcometer 456, Type II (Appendix H) to ensure compliance with project requirements. For measurement purposes, ERDC-CERL required the use of the Naval Sea Systems Command (NAVSEA)-sponsored QA Toolkit (Figure 8) to support an Army evaluation of the NAVSEA/National Surface Treatment (NST) Center QA Toolkit database. (User feedback was being ob-

tained for the Navy as part of a separate task). A certified National Association of Corrosion Engineers (NACE) coating inspector trained on the QA Toolkit system measured the coating thickness at designated locations. All inspection activities (e.g., surface profiles, surface conditions, temperature, humidity, and coating thickness) were entered into the system and recorded.

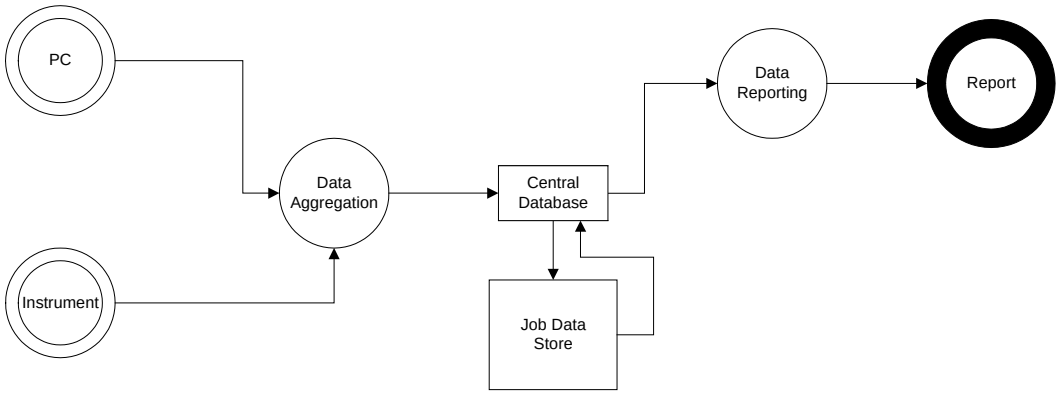


Figure 8. NAVSEA/NST Center inspection system.

The coating process consisted of priming with the CNT/zinc hybrid primer, applying the intermediate epoxy primer coat, and then finishing with a polyurethane topcoat. All were applied according to the manufacturer's specifications (Appendix E) and UFGS Section 09 97 13.27. Several issues arose during the coating process and had to be addressed. Requests were made to approve a lower temperature threshold for the coating application due to severe conditions that challenged the environmental controls. Another problem was the topcoat having a shadow effect due to poor color coverage over the white intermediate primer, even though it was applied to the correct dry film thickness (DFT). A waiver was requested and approved to increase the total coating system thickness from 0.013 to 0.015 in. The tank surface was prepared and a recoat of the topcoat applied to achieve an acceptable cosmetic appearance. The applicator reported that all total thickness measurements indicated that the total coating system and the topcoat had been applied in accordance with manufacturer's specifications (Appendix E) and for compliance with project requirements. Pictures of the successful coating application are shown in Figure 9 and Figure 10.

Figure 9. CNT/zinc primer.

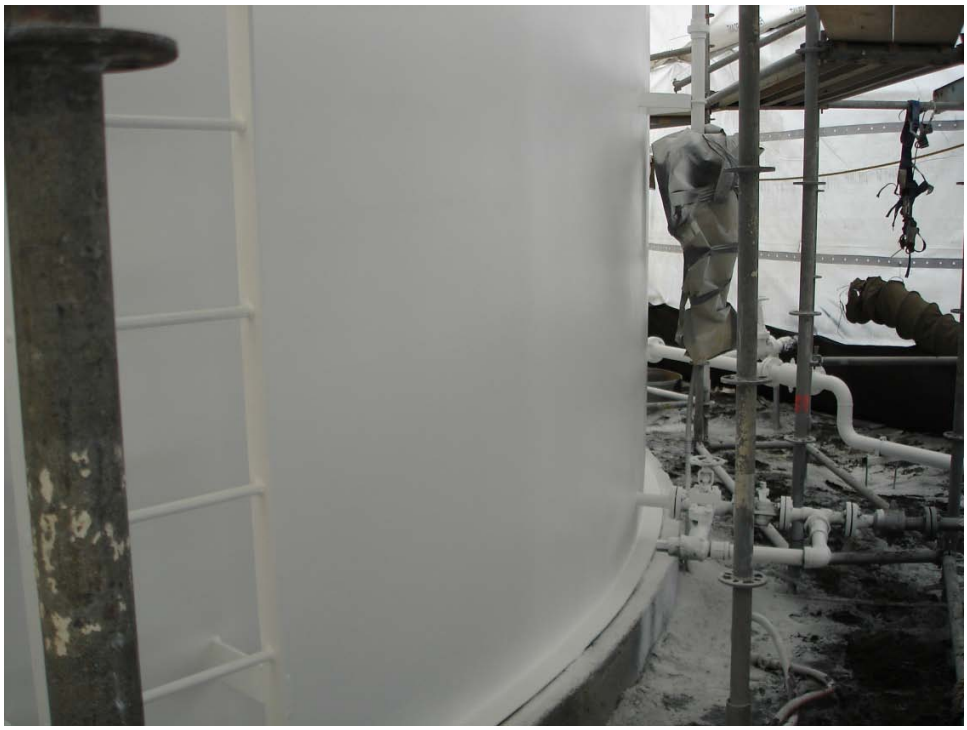


Figure 10. Intermediate epoxy primer.

At the conclusion of coating activities, the tank base was sealed to the concrete pad using Sikaflex-1A sealant (Appendix F) as shown in Figure 11.

Figure 11. Sikaflex sealant at tank base.

2.2.2 Associated piping for Fuel Oil Tanks #1 and #2

The fuel line piping was severely corroded for tanks #1 and #2 and two small horizontal tanks within the containment area. The piping required rehabilitation and corrosion protection. Refinishing of these lines presented challenges due to an electrical conduit running parallel with the fuel lines. The conduit had to be either protected or removed. Special enclosures had to be constructed and environmental controls applied for the blasting and coating operations. The electrical conduit was removed in most cases, and special containment was constructed as shown in Figure 12 and Figure 13.

The fuel line piping was treated with the same process used on tank #2. The lines were blasted per UFGS Section 09 97 13.27 (Figure 14), and SSPC SP 10 and operations coordinated so bare metal would not be exposed for more than 8 hours between blasting and coating. When conditions or scheduling caused delays exceeding 8 hours, all affected areas were reblasted. Coating procedures and specifications were identical to those used on tank #2. A special effort was made to ensure that the manufacturer's specified minimum thickness was applied to all complex surface areas. Where spray application was not effective, brush/roller equipment was used consistent with the paint manufacturer's recommendations. Figure 15 – Figure 17 are representative of the blasting and coating process on the piping, and Figure 18 shows some of the completed piping and the completed tank.

Figure 12. Preparation of piping containment.

Figure 13. Piping containment with environmental controls.

Figure 14. Abrasive blasting of piping.

Figure 15. Hybrid CNT/zinc primer on piping.

Figure 16. Intermediate epoxy primer on piping.

Figure 17. Finished piping with MIL-PRF-85285 polyurethane topcoat.

Figure 18. Completed fuel oil tank #2 and piping.

2.3 Technology monitoring

To evaluate the performance and effectiveness of these coatings, it was necessary to install an exposure rack for test coupons. Scribed steel test coupons were prepared at the site with the coating systems used on tank #2. These coupons (Figure 19 and Figure 20) were mounted in a test rack for environmental exposure and deployed at the plant site for testing on 2 February 2009. Three additional uncoated steel coupons of 1010 mild carbon steel were installed on 16 April 2009.

Figure 19. Blasted coupons.

Figure 20. Exposure rack with coupons prepared with the coating systems used on tank #2.

2.4 Data collection

Data collection on the coating application was collected using the NAVSEA/NST Center QA Toolkit to document proper application and to assure it met all required parameters of UFGS Section 09 97 13.27. Daily logs were used to document the work performed on the piping and are at Appendix I. Data collection on coating performance was accomplished through quarterly visits to Fort Bragg to assess the coupons, the condition of tank #2 and piping; these results are at Appendix J.

3 Discussion

3.1 Metrics

The results of this project were assessed against the following metrics:

- ASTM D1014, "Standard Practice for Exterior Exposure Tests of Paints and Coatings on Metal Substrates" was used in the preparation and coating of all test panels.
- ASTM Test Method D1654, "Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments," procedure A, method 2, and procedure B were used in the evaluation of the scribed coating test panels.
- Visual aesthetics of finished coating system acceptable to the DPW and the garrison's senior leadership.

Daily temperature, dew point, and humidity measurements, surface profile, and paint thickness readings were documented using the QA Toolkit and the data uploaded to the NAVSEA/NST Center database.

3.2 Results

This dem/val project began on 3 November 2008. Work was successfully completed on fuel oil tank #2 and associated piping in the containment area on 16 January 2009. The NAVSEA/NST Center QA Toolkit was used to ensure that the coatings were being applied in accordance with project specifications.

The coating system performed well based on the quarterly assessments documented at Appendix J. They showed that all requirements and metrics for the coating performance were achieved. The assessment parameters did not involve comparative analysis by MEC with other similar coating systems and a correlation of performance against them was not made. The assessment showed the test coating system — CNT/zinc hybrid primer, the intermediate primer, and topcoat — to be a very effective new coating system for preventing corrosion on steel structures. This coating system will contribute significantly to reducing the cost of maintaining steel equipment and infrastructure throughout DoD.

This dem/val showed the application of advanced corrosion resistant coatings coupled with traditional installation technology. It illustrated the significant improvements this technology has for performance to extend the service life of facility assets in the DoD and around the world through corrosion protection. It also advances priorities in coupling increased material service longevity with improved corrosion protection.

The principal constraints experienced by the contractor were a result of adverse weather conditions. The impact on the application processes were mitigated by a containment system and the use of heat and dehumidification equipment. Any deviations in the prescribed methods of preparation and coating application parameters were resolved cooperatively by ERDC-CERL, MEC, the Fort Bragg DPW, and J&W of North Carolina.

3.3 Lessons learned

Significant pre-planning and preparation for staging with regard to the installation process and onsite management and QA contributed to the successful application of the demonstration coatings and keeping to schedule.

The work was accomplished during the time of year with the most adverse weather, so application conditions were not ideal. The temperature parameters for the coating application (set at 60 °F) could not be met even with a containment system and environmental controls. Authorization was granted to permit application at 50 °F. The CNT/zinc hybrid primer performed very well under these conditions, demonstrating that it has a broader flexibility for use under less-than-desirable conditions.

3.3.1 Site selection

The selection of the Heating Plant tanks #1 and #2 site was ideal. The area provided sufficient room to support staging of equipment and storage facilities. The abrasive blasting and coating application operations generate significant dust and paint residue that must be contained. The site was remote enough that operations did not cause concern or disrupt any base activities.

3.3.2 Application

Planning and coordination is a key element in the successful execution of the coating technology demonstrated in this project. The application of the CNT/zinc hybrid primer met the project metrics requirements. The coating can be applied with conventional application equipment, and it performs well under less-than-desirable conditions, such as ambient temperatures at the lower limit of the permissible application range. The coating must be applied over white blasted metal surfaces, so the blasting and coating operations must be well coordinated. For example, if more surface area is blasted than can be coated within the required 8 hour recoat time, light oxidation will form on any remaining bare steel and those surfaces will have to be re-blasted before coating operations can continue. Therefore, blasting production must be carefully timed to avoid slowing down the coating work while avoiding too much surface area exposure that might lead to excessive rework.

The CNT/zinc hybrid primer coating can be applied and used under all the same conditions as traditional zinc-rich primers. Because of the reduced pigment content and CNT-enhanced mechanical and electrical properties, the CNT/zinc hybrid primer demonstrates advances over zinc-rich coatings. The material has a lower weight per gallon, which improves the handling of bulk materials and makes them easier to mix. The lower zinc content improves application properties such as sag resistance and edge retention, and it reduces clogged spray gun tips. The dried coating is lighter, which reduces the load on the structure.

4 Economic Summary

4.1 Costs and assumptions

The labor, equipment and material costs for applying the coating to the fuel tank are shown in Table 1 and Table 2. The return on investment analysis is based on three assumptions: (1) the new coating will increase the required touchup interval from 6 to 30 months, and the necessary recoating interval from 24 to 120 months, (2) the cost to coat the tank with a conventional system is the same as the cost using the demonstrated system, except that the conventional coating materials costs 50% less, (3) the material and labor cost of touch-up is 5% of the cost of the material and labor of recoating.

Table 1. Labor costs.

Activity	Cost
Abrasive Blast and Painting Labor (1440 man-hours x $42.50)	$61.200
Per Diem	$18,000
QA and CIH Consultant	$20,000
Mobilization and Demobilization	$8,873
Total Labor Costs	$108,073

Table 2. Equipment and material costs.

Item	Cost
Containment System	$25,000
Generator	$9.500
Dust Collector	$10,000
Air Compressor	$8,000
Diesel	$15,500
Misc. (wash facilities, etc)	$5,300
Dehumidification Equipment	$5,000
Heating Equipment	$10,000
Abrasive and Disposal	$16,000
Coatings & Thinner	$57,037
Total Equipment and Materials	$161,337
Total Labor, Equipment, and Materials	$269,410

4.2 Projected return on investment (ROI)

The project yielded adequate data to perform an ROI analysis in accordance with OMB Circular A-94 methodology. The costs for painting and touching up the tank are from the project costs given in the previous section. A tank failure and replacement costing $8,000,000 is predicted in year 21. Using the full project cost of $950,000 as the investment required, the project ROI is calculated at 2.67, as shown in Table 3.

The full project costs include all and research and development and support costs. The actual implementation cost at Fort Bragg was $269,410. This figure includes the cost of heating and dehumidification equipment, which were required for painting the full tank in the cold winter months. On projects with a more flexible schedule, these costs can be avoided. Using the actual implementation costs, a more favorable ROI of 9.43 is calculated.

Table 3. Validated return on investment calculation.

Investment Required							950,000
Return on Investment Ratio					2.67	Percent	267%
Net Present Value of Costs and Benefits/Savings					67,945	2,608,691	2,540,746
Future Year	Baseline Costs	Baseline Benefits / Savings	New System Costs	New System Benefits / Savings	Present Value of Costs	Present Value of Savings	Total Present Value
1	240,892					225,138	225,138
2							
3	12,045					9,832	9,832
4							
5	12,045					8,588	8,588
6	240,892					160,506	160,506
7							
8	12,045					7,010	7,010
9							
10	12,045					6,122	6,122
11	240,892					114,448	114,448
12							
13	12,045					4,999	4,999
14							
15	12,045		89,803		32,545	4,365	-28,179
16	240,892					81,590	81,590
17							
18	12,045					3,564	3,564
19							

20	12,045					3,112	3,112
21	8,000,000					1,932,000	1,932,000
22							
23	12,045					2,540	2,540
24							
25							
26	240,892					41,482	41,482
27							
28	12,045					1,812	1,812
29							
30	12,045		269,410		35,400	1,583	-33,818

5 Conclusions and Recommendations

5.1 Conclusions

The application of the standard three-part epoxy coating system — consisting of an organic zinc-rich primer, an epoxy intermediate coating, and a urethane topcoat — used on many steel structures is very labor intensive and expensive to apply and maintain. The three-part system is used extensively in the DoD and Department of Transportation for equipment and structures located in environments conducive to medium to severe corrosion.

The primary purpose of the metallic zinc-loaded primer is to provide a coating that will cathodically protect properly prepared steel substrate surfaces. Organic zinc-rich primer coating normally contains between 65% and 95% metallic zinc powder in the cured paint film. This heavy loading of zinc powder is necessary to achieve the cathodic protection of the steel substrate, which is achieved when the metallic zinc-loaded primer is applied so that the zinc particles come in contact with each other and the bare steel substrate. Conductivity between the zinc particles and properly prepared steel substrates allows the zinc particles to galvanically protect the substrate. The "throwing power" of the sacrificial zinc metal allows for the protection of minor damage to the steel substrate while the zinc is consumed in the process. The heavy loading of the zinc powder, combined with the reduced resin packages/binders, can cause a high-build coating thickness that can be prone to chipping and "mud cracking" if not properly applied.

The primer demonstrated in this CPC project was designed to inhibit corrosion by forming a cathodically protective coating using a CNT additive in order to reduce the amount of metallic zinc powder used in conventional primers. The data produced in this project support the use of CNT in conjunction with the reduced loading of metallic zinc particles. This innovative nanocoating system is designed to inhibit corrosion of steel by forming a barrier film and a cathodically protective coating. The CNT additive facilitates the transfer of electrons by creating an electron path through the binder and between the cathodic substrate and anodic sacrificial metals. This characteristic shifts the potential of the environment to a less-corrosive cathodic potential to produce an effective corrosion-

inhibiting primer that is much lighter in weight, stronger, tougher, abrasion-resistant and more environmentally acceptable than conventional zinc-rich primers.

Final evaluation of the test coupons found a tight oxide corrosion film in all scribed areas. No topcoat lifting, blistering, or undercutting at the scribe edge or zinc corrosion product residue was detected on any of the fully coated test panels. It was noted that the intermediate primer did chip along the scribe line on all test panels that were not topcoated. The chipping was an interlaminar failure of the intermediate primer only; the base CNT/zinc primer remained intact.

During the project, the MSDS and select carbon nanotube-related literature [1, 2, 3, 4] were reviewed. The use of CNT in applications such as coatings and composites is a relatively new technology area, so a definitive determination of CNT toxicity and the potential for exposure associated with use in these materials has not been established. While the MSDS review did not reflect any unusual risks associated with the CNT-containing primer, other carbon nanotube reference material reviewed indicate that, under certain conditions, nanotubes may be able to cross membrane barriers. This suggests that, if they are ingested, inhaled, or otherwise enter the body, nanotubes can induce harmful effects such as inflammatory and fibrotic reactions [1, 2, 3, 4]. Concerns about worker exposure to carbon nanotubes or nanofibers are based on animal studies [5]. As researchers continue to investigate the biological effects of exposure to carbon nanotubes and nanofibers, precautionary measures are advised during the handling of dry materials in the coating manufacturing process. Once these dry nanotubes are dispersed into the liquid epoxy resin components, they are unlikely to be released by any downstream processing, including coating application, exposure to weather, or paint removal by abrasive blasting or other means. The definitive requirements for the safe handling of these materials will be established by the Department of Health and Human Services, Centers for Disease Control and Prevention, and the National Institute for Occupational Safety and Health. Users of the nanomaterial-modified primer and other materials containing CNTs should always refer to the manufacturer's current Materials Safety Data Sheets for guidance on handling the materials and the use of appropriate personal protection equipment (PPE)

5.2 Recommendations

5.2.1 Applicability

It is recommended that the CNT/zinc-rich primer system, intermediate primer, and polyurethane topcoat system be used to replace the standard three-part coating system now applied to prevent corrosion on steel structures such as storage tanks, towers, and pipelines.

It is further recommended that CNT-containing coating overspray should be carefully contained and removed. Applicators should wear appropriate PPE and skin barrier materials as prescribed by the coating manufacturer's MSDS and applicable regulations. As with any other hazardous material, the used PPE should be handled in such a way to prevent the dried CNT-containing material from becoming airborne and inhaled or ingested.

5.2.2 Implementation

Additional laboratory work will be completed at the ERDC Paint Technology Center to develop performance standards for the CNT-modified coating system. The performance standards and guidance on the selection and use of the coating system will be published at a future date; and revisions of the applicable Unified Facilities Guide Specifications and an Engineer Technical Letter will be submitted.

Table 4 lists documents recommended for revision to promote implementation of the modified coating system.

Table 4. Guidance documents recommended for change.

Document	Title
UFC 3-190-06	Protective Coatings and Paints
UFGS 05 12 00	Structural Steel
UFGS 09 97 13.00 40	Steel Coatings
UFGS 09 97 13.27	Exterior Coating of Steel Structures
UFGS 33 16 15	Water Storage Steel Tanks (Exterior Surfaces Only)

Note: UFC is Unified Facilities Criteria; UFGS is Unified Facilities Guide Specification.

References

[1] Kolosnjaj., J., H. Szwarc, and F. Moussa. 2007. "Toxicity studies of carbon nanotubes." *Adv Exp Med Biol.* 620:181–204. doi:10.1007/978-0-387-76713-0_14. PMID 18217344.

[2] Lam, C. W., J. T. James, R. McCluskey, S. Arepalli, and R. L. Hunter. 2006. "A review of carbon nanotube toxicity and assessment of potential occupational and environmental health risks." *Crit Rev Toxicol.* 36(3):189–217. doi:10.1080/10408440600570233. PMID 16686422.

[3] Poland, Craig A., Rodger Duffin, Ian Kinloch, Andrew Maynard, William A. H. Wallace, Anthony Seaton, Vicki Stone, Simon Brown, William MacNee, and Ken Donaldson. 2008. "Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study." *Nature Nanotechnology* 3:423-428. doi:10.1038/nnano.2008.111.

[4] Porter, Alexandra, Mhairi Gass, Karin Muller, Jeremy N. Skepper, Paul A. Midgley, and Mark Welland. 2007. "Direct imaging of single-walled carbon nanotubes in cells." *Nature Nanotechnology* 2:713. doi:10.1038/nnano.2007.347.

[5] National Institute for Occupational Safety and Health (NIOSH). November 2010 draft. "Occupational Exposure to Carbon Nanotubes and Nanofibers." *NIOSH Current Intelligence Bulletin*. Atlanta, GA: Department of Health and Human Services Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

Abbreviations

Term	Definition
ASTM	American Society for Testing and Materials
CNT	carbon nanotube
CPC	Corrosion Prevention and Control
dem/val	demonstration/validation
CERL	Construction Engineering Research Laboratory
DoD	Department of Defense
DPW	Directorate of Public Works
ERDC	Engineer Research and Development Center
HWAS	Hazardous Waste Accumulation Site
MEC	Mandaree Enterprise Corporation
NACE	National Association of Corrosion Engineers
NAVSEA	Naval Sea Systems Command
NST	National Surface Treatment (Center)
OSD	Office of the Secretary of Defense
PPE	personal protective equipment
QA	quality assurance
ROI	return on investment
SOW	scope of work
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification

Appendix A: MEC Project Management Plan

WORK PLAN

APPLICATION OF INNOVATIVE COATING SYSTEM ON THE EXTERIOR OF A FUEL OIL TANK AT FORT BRAGG, NC

September 16, 2007

1. PROJECT OBJECTIVE: Preliminary research on a number of advanced coating systems is underway at the ERDC CERL Paint Technology Center. Industry has developed innovative paint additives designed to inhibit corrosion by forming both a high quality barrier film and a cathodically protective coating that does not require the high pigment loading of a traditional zinc-rich primer. The technically advanced additives utilize either an electroactive inherently conductive polymer (ICP) or galvanically inactive single wall carbon nanotubes (SWNT)* in conjunction with sacrificial metals to produce galvanic reactivity with the substrate. One of the products using these technologies has been selected to coat the exterior surfaces of a 200,000 gallon fuel oil tank at Fort Bragg, NC. The overall objective of this task order is to clean the tank exterior to bare steel by abrasive blasting, apply the designated coating system, and monitor the performance of the coating system.

In addition, coated test panels will be prepared and exposed on a separate rack at the test site, per ASTM standard methods. Coatings shall include the ICP and SWNT coating systems, and other similar test coatings selected by ERDC CERL, as well as the currently specified coating systems based on the traditional zinc-rich primer, similar coating systems without a zinc rich primer, and bare metal coupons. The coating panel rack will be installed at the time of coating application and near the fuel oil tank. The same paint systems will be tested in the laboratory to measure coating adhesion, flexibility, impact resistance, and other performance properties.

* The actual material source used in this demonstration did not consist solely of single-walled nanotubes, so the less-restrictive term *carbon nanotube* (CNT) is used in final documentation of CPC project F07-AR19.

Once applied, the coating systems will be evaluated for performance, return on investment, and consideration for wider application within the Army and Department of Defense.

2. MAJOR REQUIREMENTS: MEC and its subcontractors will be responsible for all work and materials necessary to prepare the surfaces and apply test coatings on the exterior surfaces of the fuel oil tank at Fort Bragg, NC.

Work will also include removal and disposal of all waste, including but not limited to, existing coating materials removed, spent abrasive media, paint containers, application waste and all other refuse that may be generated at the sites. This waste will be entirely removed from the installation. At the conclusion of the project, each site will be completely clean. Paint overspray on other surfaces will be removed and all surfaces returned to their original condition. All damage done to surrounding areas or surfaces will be repaired to original conditions.

MEC and its subcontractors will complete all work in a neat and orderly manner in accordance with OSHA, EPA, State of North Carolina, and Army Environmental regulations. MEC will be responsible for complying with all safety and environmental regulations that may be in effect at the site. Work will be performed in accordance with the requirements of the Task Order for this project as well as the requirements of 29 CFR 1910, 29 CFR 1926, EM 385-1-1 and the guidance provided by the manufacturers of the various coatings in the pertinent Material Safety Data Sheets (MSDS).

To successfully complete the work defined in this Task Order, MEC will complete the following tasks:

a. Task 1. MEC and its subcontractors will conduct paint removal, surface preparation and paint application to the exterior surfaces of the fuel oil tank in accordance with Section 09 97 13.27 of the contract (attachment 1.). Primer (Components A and B), Intermediate Coat, and Topcoat materials will be obtained from a single manufacturer to ensure compatibility. The Government will drain the tank prior to the work. The work schedule will be coordinated in advance with the Fort Bragg DPW POC to accommodate the draining of the tank.

MEC will arrange to have a person on-site representing the test coating manufacturer during the field work to advise the COTR on technical as-

pects of the surface preparation and handling, mixing application and curing of the paint system. MEC will coordinate consultations between the manufacturer and the COTR.

MEC will submit the following Plans, Reports, and Qualification statements for Government approval a minimum of 30 days prior to the start of work at the site. MEC will not proceed with work at the site until the Government has approved each plan.

- Containment System Design
- Joint Sealant Qualification Test Reports
- Coatings Qualification Test Reports and Color Chip
- Work Plan
- Accident Prevention Plan
- Qualifications of Certified Industrial Hygienist
- Qualifications of Coating Contractors
- Joint Sealant Manufacturer's Instructions
- Certification of Joint Sealant Conformance to Specifications
- Coating System Manufacturer's Instructions
- Coating Qualification Test Reports

MEC will submit paint and abrasive samples to the ERDC-CERL Paint Technology Center a minimum of 30 days prior to the start of on-site work.

During the course of the work on-site, daily Inspection Reports will be sent by fax or email to the COTR.

MEC will submit disposal of spent abrasives and inspection logbook to the COTR 15 days after the on-site work (Tasks 1 – 3) is complete.

b. Task 2. Test Panels – For each coating system used above, MEC will prepare six coated test panels. Test panels will be mild steel, 3 by 9 inches, and will be prepared and coated in the same manner as the structure components. For the set of fuel oil tank coated panels, four will be shipped to ERDC-CERL for accelerated exposure testing and the others will be exposed on the corrosion test rack at Fort Bragg, NC in accordance with ASTM-D1014 "Standard Practice for Exterior Exposure Tests of Paints and Coatings on Metal Substrates." The test panels exposed on the corrosion test rack will be scribed to base metal in accordance with ASTM

Test Method D1654 “Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.”

c. Task 3. Exposure Rack – MEC will set up a test panel exposure rack to accommodate approximately 20-coated steel panels prepared in accordance with Task 2. The location of the test rack will represent the exposure conditions of the test coatings on the structure. MEC will mount pairs of duplicate test panels (outlined in Task 2) on the rack prior to or no later than 15 days after completion of coating work on the structure.

d. Task 4. Monitor Coating System Performance. - MEC will evaluate and document the performance of the test panel coatings and the tower itself at approximately 3-, 6-, 9- and 12-months of exposure in accordance with ASTM Test Method D 1654. MEC will evaluate the scribed test panels in accordance with Procedure A, Method 2, and with Procedure B. Evaluate the performance of the coating on the tower itself in accordance with Procedures B and D, and include an evaluation of the coating on representative areas of both the support structure and the exterior tank wall. The results of all evaluations will be documented for inclusion in the succeeding monthly report and in the final report. Documentation will include photographing the test panels prior to exposure, and at approximately 3-, 6-, 9-, and 12-months after installation.

e. Task 5. Return on Investment (ROI). - MEC will conduct a Return on Investment analysis. Information will include the actual cost and quantity of each specific expendable material used, the costs of equipment and mobilization, and the actual man hours by trade required to apply the coating system. MEC will provide all data to the project COTR in the draft/final report. NOTE: This information will only be used to determine life cycle costs and will not be used in any manner that could influence future work by MEC.

3. MEETINGS/REVIEWS: MEC will coordinate one pre-job conference at Fort Bragg, NC with the COTR.

4. TRAVEL: MEC will conduct all field work at Fort Bragg, NC and will be responsible for all travel costs necessary to perform the work of the task order. MEC will travel to Fort Bragg for a pre-job conference, and will conduct all travel necessary to complete the work required in this task order. Dates of coating application and subsequent performance monitoring will be coordinated with the COTR.

5. REPORTS/DELIVERABLES: During the course of this task order, MEC will submit the following reports as outlined in Section 09 97 13.27, attachment 1 to the CERL COTR:

a. Thirty days prior to the start of field work:

- Containment System Design
- Joint Sealant Qualification Test Reports
- Coatings Qualification Test Reports
- Coating Sample Test Reports
- Work Plan
- Accident Prevention Plan
- Joint Sealant Manufacturer's Instructions
- Coating System Manufacturer's Instructions

b. Paint and Abrasive Samples: Paint and abrasive samples will be submitted to the ERDC-CERL Paint Technology Center a minimum of 30 days prior to the start of on-site work.

c. Daily Inspection Reports: During the course of the on-site work, Daily Inspection Reports will be sent by fax or e-mail to the COTR.

d. Closeout Reports: Fifteen days after the on-site work (Tasks 1 through 3) is complete closeout reports (disposal of spent abrasives and inspection logbook) will be submitted to the COTR.

e. Monthly Progress Reports: MEC will submit Monthly Progress Reports in accordance with the requirements of this Task Order.

f. Draft and Final Reports: MEC will fully document the project with a Draft and Final Report, with major sections as follows:

- Introduction (including who, where, what, and acknowledgements)
- Executive Summary
- Background
- Lessons Learned
- Technical Investigation (statement of the problem, approach, findings planned vs. actual and other note worthy tangibles, and include all technical documentations: safety/quality plans, photographs, SOPs, data collection and test/eval procedures, test results, lessons learned, etc.)

- Economic Summary (Projected ROI)
- Recommendations for implementation at other sites or on other steel structures
- Implementation (recommendations for further implementation across the DOD, and contract specification language that can be used to implement the technology at other sites. Use UFGS 09 97 13.27 as a specification guide, and recommend the modifications required to incorporate the zinc dust replacement into the primer specified.)
- Conclusions
- Appendices (technical investigation attachments)

6. PERIOD OF SERVICE: MEC will complete Tasks 1 through 3 no later than 30 November 2008. Task 4 will be completed no later than 30 November 2009. All other work to be performed under this task order will be completed no later than 31 December 2009.

Appendix B: Toxic Characteristic Leaching Procedure (TCLP) Report

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.
7469 WHITE PINE ROAD - RICHMOND, VA 23237
804-275-4788 FAX 804-275-4907

METAL TCLP ANALYSIS SUMMARY

CLIENT: J & W of North Carolina, Inc.
1040 Old Washington Road
P.O. Box 1069
Vanceboro, NC 28586

DATE OF SAMPLING: 25 Apr 2008
DATE OF RECEIPT: 28 Apr 2008
DATE OF ANALYSIS: 30 Apr 2008
DATE OF REPORT: 30 Apr 2008

CLIENT NUMBER: 34-3837 A
EHS PROJECT #: 2008-04-2632
PROJECT: 38' Dia Fuel Tank; Ft. Bragg, NC

EHS SAMPLE #: 2008-04-2632-01
CLIENT SAMPLE #: Exterior
LAB. GROSS DESCRIPTION: Blast Media

SAMPLE DATE: 25 Apr 2008
TCLP INITIAL pH: 7.35
SAMPLE WEIGHT (g): 100

ANALYTE	RESULT (mg/L)	REPORT LIMIT (mg/L)	MDL (mg/L)	METHOD	REGULATORY LIMIT (mg/L)
SILVER (Ag)	<0.050	0.050	0.0005	EPA SW846 1311/3010B/6010B	5.0
ARSENIC (As)	<0.050	0.050	0.0044	EPA SW846 1311/3010B/6010B	5.0
BARIUM (Ba)	2.0	0.050	0.0002	EPA SW846 1311/3010B/6010B	100
CADMIUM (Cd)	<0.050	0.050	0.0005	EPA SW846 1311/3010B/6010B	1.0
CHROMIUM (Cr)	<0.050	0.050	0.0011	EPA SW846 1311/3010B/6010B	5.0
LEAD (Pb)	0.21	0.050	0.0017	EPA SW846 1311/3010B/6010B	5.0
SELENIUM (Se)	<0.050	0.050	0.0052	EPA SW846 1311/3010B/6010B	1.0
MERCURY (Hg)	<0.001	0.001	0.0001	EPA SW846 1311/7470A	0.20

QUALITY CONTROL ANALYTE	SPIKE RECOVERY	DUPLICATE RELATIVE PERCENT DIFFERENCE (RPD)
SILVER (Ag)	104%	0.477%
ARSENIC (As)	112%	1.78%
BARIUM (Ba)	103%	0.966%
CADMIUM (Cd)	107%	0.00%
CHROMIUM (Cr)	102%	0.487%
LEAD (Pb)	100%	0.995%
SELENIUM (Se)	113%	1.75%
MERCURY (Hg)	100%	0.00%

ANALYST: David Xu

Reviewed By Authorized Signatory:

Michael A. Mueller, MPH, Laboratory Director
Howard Varner, General Manager
Irma Faszewski, Quality Assurance Coordinator
David Xu, MS, Senior Chemist

Fax: Apr 30 2008 05:08pm P003/004

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.

CLIENT NUMBER: 34-3837 A
EHS PROJECT #: 2008-04-2632
PROJECT: 38' Dia Fuel Tank; Ft. Bragg, NC

Method EPA SW846 1311 recommends 100g for analysis.

The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report. Results represent the analysis of samples submitted by the client. Sample location, description, area, volume etc., was provided by the client. This report shall not be reproduced, except in full, without the written consent of Environmental Hazards Services, L.L.C. California Certification #2272 NY ELAP #11714

LEGEND g = gram ug = microgram ppm = parts per million MDL = method detection limit
ml = milliliter Pb = lead mg/L = milligrams per liter

tclp8mt2.1dot/ICPVISTA/07JUL2006/REV4/pd

-- PAGE 02 of 02 -- END OF REPORT --

Apr 30 2008 05:08pm P004/004 Fax:

ENVIRONMENTAL HAZARDS SERVICES, L.L.C.

1 RCRA 8 EHS 2008-04-2632 chmond, Virginia 23237 Phone (804) 275-4788 Fax (804) 275-4907

CHAIN OF CUSTODY FORM

Company Name: J&W of North Carolina, Inc.
Address: 1040 Old Washington Road P.O. Box 1069
City, State, Zip: Vanceboro, NC 28586
EHS Client Account #: 34-3837 A
Phone #: (252) 244-3600 **Fax #:** (252) 244-3605
P.O. #: 3830

Date: 4/25/8
Contact Name: Debbie Bradley
Sampler Name: Frank Stevens
Project #: 38' Dia. Fuel Tank Ft. Bragg, NC

Sample Number	Sample Date & Time	Asbestos: Bulk ID by PLM	Asbestos: (PCM) Fiber Count	Asbestos: PLM Point Count	Asbestos: PLM Gravimetric	Asbestos: TEM AHERA (Air)	Asbestos: TEM Chatfield (Bulk)	Lead: Air	Lead: Paint (%)	Lead: Paint (PPM)	Lead: Paint (mg/cm²)	Lead: Soil	Lead: Wipe * (See Note)	Lead: TCLP (Pb)	Lead: Waste Water	Other Metals (Specify metals below): TCLP RCRA 8	Other Metals: Welding Fume	Other Metals: Toxic Metal Profile	Air Volume (L) OR Wipe Area (ft²) OR Scrape Area(cm²)	Comments
Exterior	11:30															X				PLEASE FAX
	4/25/8																			RESULTS ASAP TO:
																				252-244-3605

SAMPLE CONDITION upon receipt
Acceptable ✓
Unacceptable ___

* Do wipe samples submitted meet ASTM E1792 requirements? Yes ☐ No ☐

Released by:	Signature: Frank Stevens	Date/Time:
Received by:	Signature:	Date/Time: 4-28-08
Released by:	Signature:	Date/Time:
Received by:	Signature:	Date/Time:

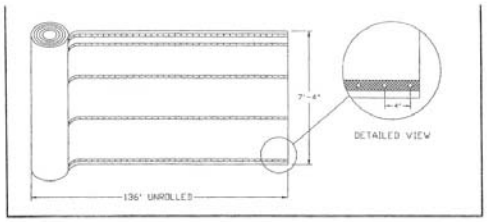
Appendix C: Containment System Design

EAGLE TARPS

REGULAR

SCAF-LITE SCAFFOLD SHEETING

FLAME RETARDANT

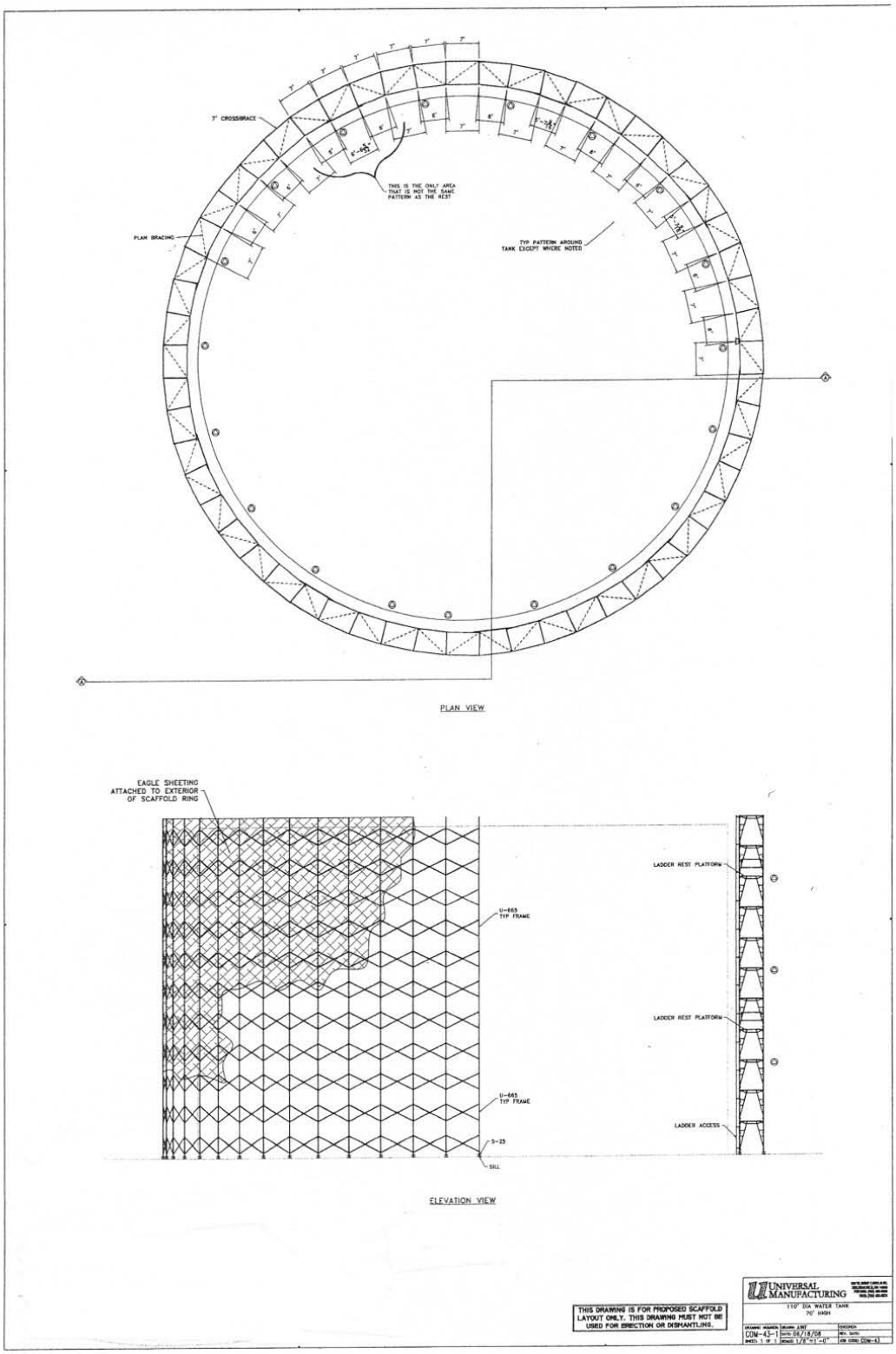


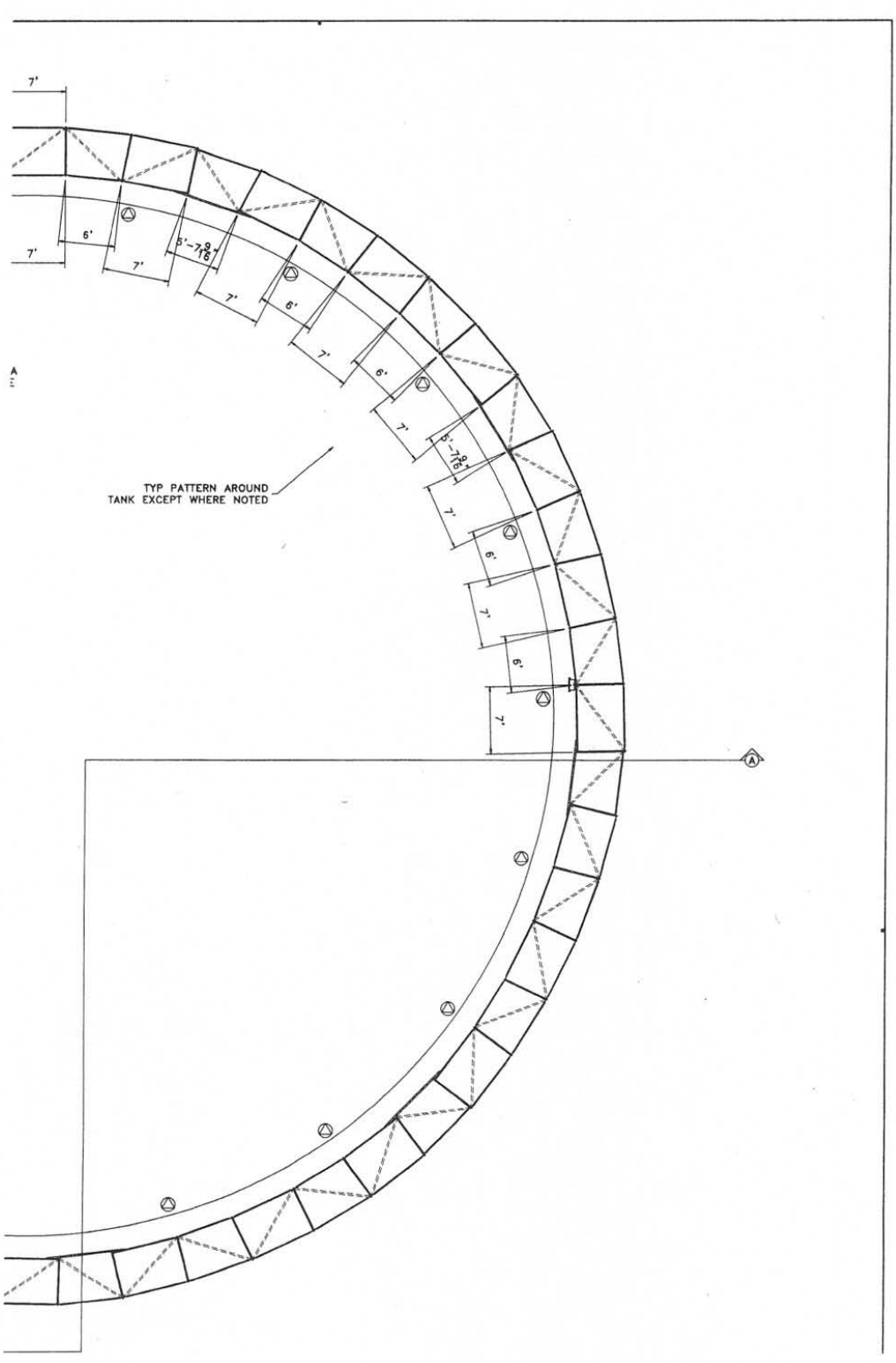
SCREW-LOC

BUNGEE CORD

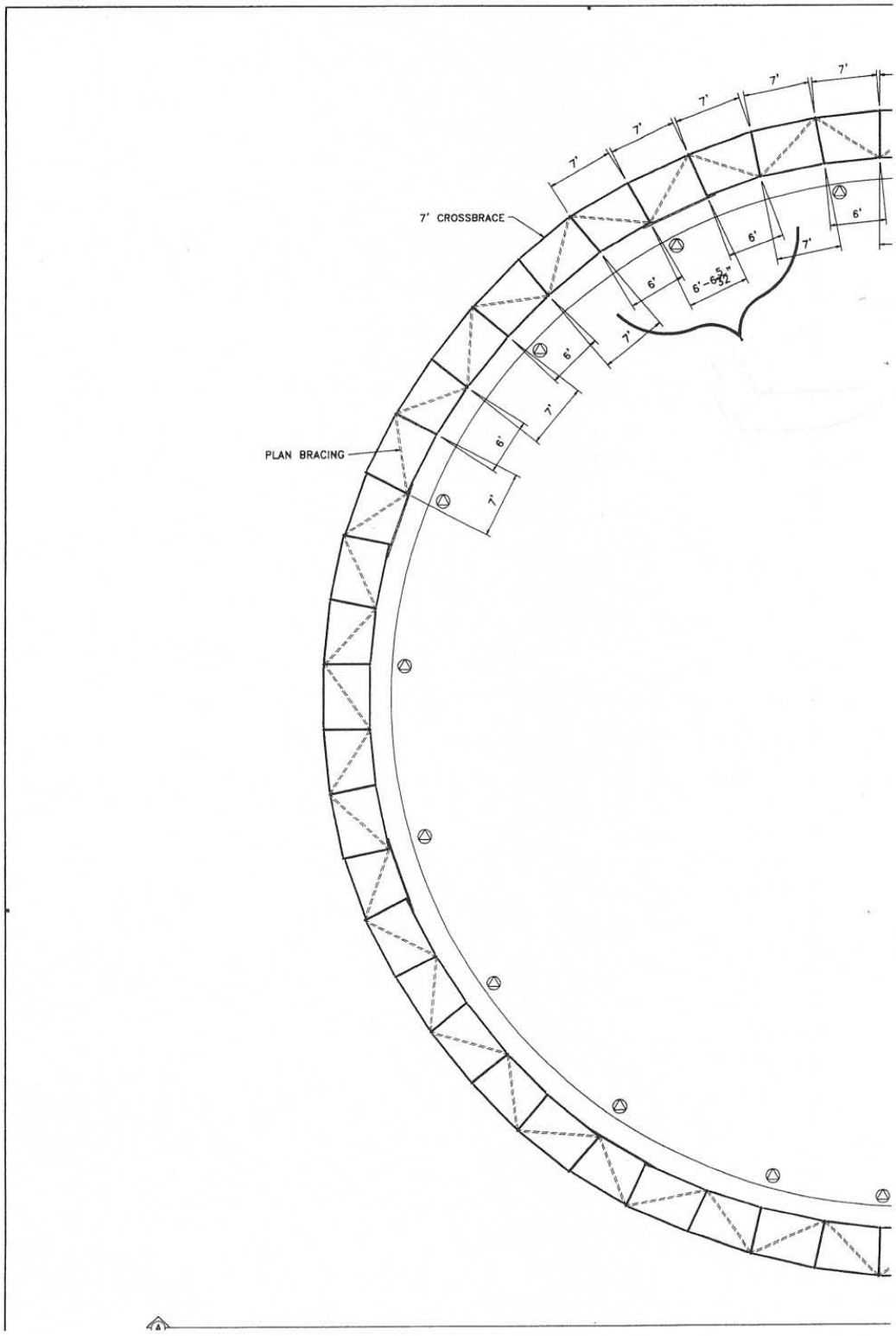
PHYSICAL PROPERTIES	UNIT	SCAF-LITE SCAFFOLD SHEETING	ROLL SIZES	
Dimensions			7' 4" X 136'	13' X 100'
Color		Non-Flame Retardant clear with white scrim Flame Retardant opaque with white scrim	Stock Stock	------ Stock
Shipping Weight	ea. roll		65 Lbs.	68 Lbs.
Thickness	mil	9 mil (excluding scrim and reinforcement bands)		
Webbing		Rolls equipped with reinforced webbing straps having eyelets on approximate 4" centers	5 bands; 1 double strap 3 single straps	6 bands; 1 double strap 4 single straps
Temperature		Material works well from -40° F. to +176° F.		

Composition: The leno weave scrim pattern has 2 X 900 denier and 1 X 1500 denier polyethylene yarns encased in low density polyethylene. Scrim is white

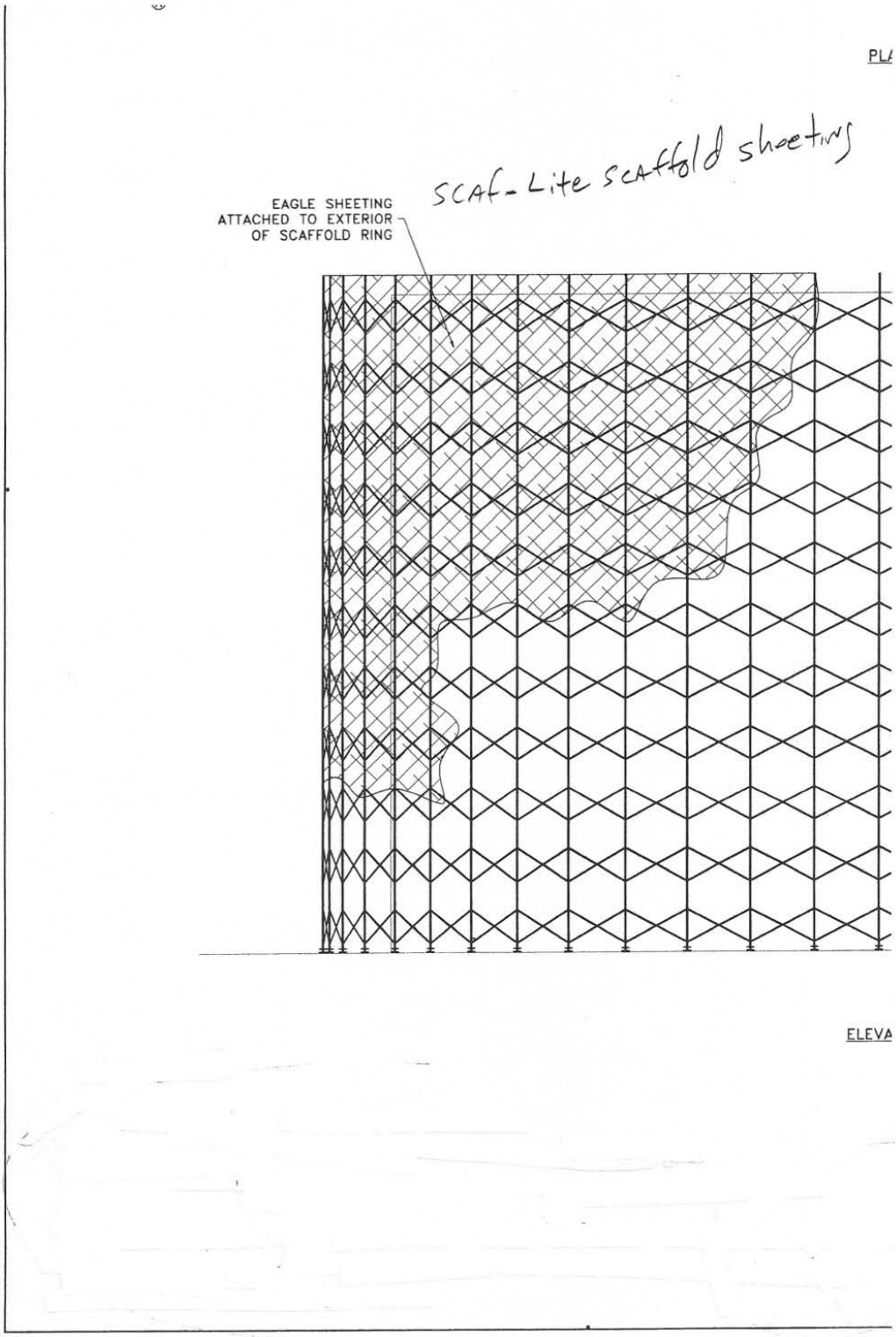

3' CROSSBRACE
THIS IS THE ONLY AREA THAT IS NOT THE SAME PATTERN AS THE REST
PLAN BRACING
TYP PATTERN AROUND TANK EXCEPT WHERE NOTED
PLAN VIEW
EAGLE SHEETING ATTACHED TO EXTERIOR OF SCAFFOLD RING
U-665 TYP FRAME
U-665 TYP FRAME
S-25
SILL
LADDER REST PLATFORM
LADDER REST PLATFORM
LADDER ACCESS
ELEVATION VIEW
THIS DRAWING IS FOR PROPOSED SCAFFOLD LAYOUT ONLY. THIS DRAWING MUST NOT BE USED FOR ERECTION OR DISMANTLING.
UNIVERSAL MANUFACTURING
110' DIA WATER TANK
70' HIGH
CON-43-1
SHEET 1 OF 3
SCALE 1/8"=1'-0"

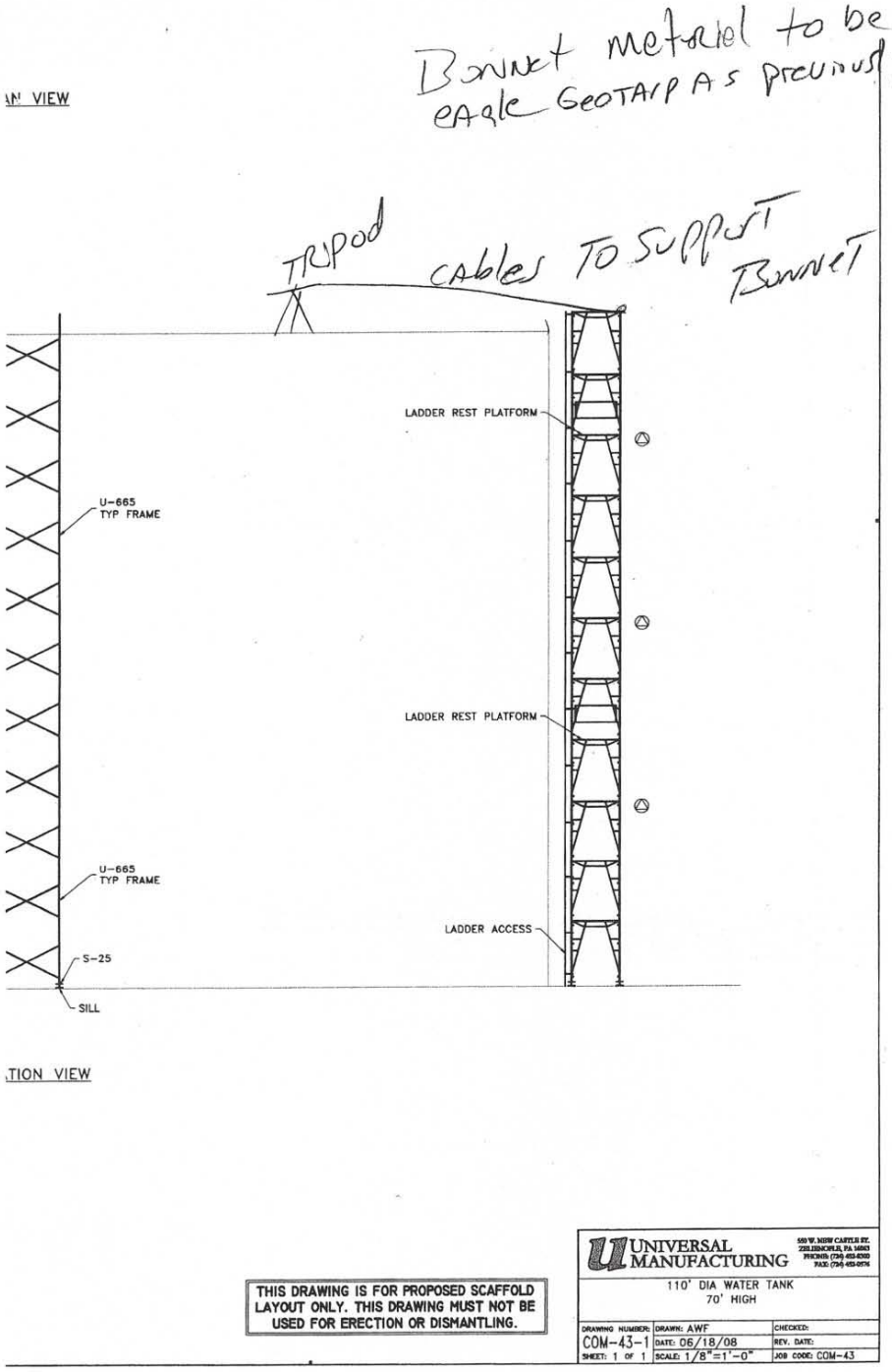

7'
6'
7'
5'-7 9/16"
7'
6'
7'
6'
7'
5'-7 9/16"
7'
6'
7'
6'
7'
TYP PATTERN AROUND
TANK EXCEPT WHERE NOTED
A
A

.3



4


PLA
SCAF-Lite scaffold sheeting
EAGLE SHEETING
ATTACHED TO EXTERIOR
OF SCAFFOLD RING
ELEVA
5


Bonnet material to be eagle GeoTarp as previously used
AN VIEW
TRIPOD
CABLES TO SUPPORT BONNET
LADDER REST PLATFORM
U-665 TYP FRAME
LADDER REST PLATFORM
U-665 TYP FRAME
LADDER ACCESS
S-25
SILL
TION VIEW
THIS DRAWING IS FOR PROPOSED SCAFFOLD LAYOUT ONLY. THIS DRAWING MUST NOT BE USED FOR ERECTION OR DISMANTLING.
UNIVERSAL MANUFACTURING
110' DIA WATER TANK
70' HIGH
DRAWING NUMBER: COM-43-1
SHEET: 1 OF 1
DRAWN: AWF
DATE: 06/18/08
SCALE: 1/8"=1'-0"
CHECKED:
REV. DATE:
JOB CODE: COM-43

Appendix D: Coating System Qualification Test Report

CERL PAINT LABORATORY TESTING REPORT

Lab Report No.: 08K100 Date: 14 November 2008

Specification: MIL-DTL-24441/19 Contract No.:

Manufacturer: Tesla NanoCoatings Limited MIPR No.:

Batch No.: a) JLH-1-011 b) JLH-1-026

Analysis:	Min	Max	Result	Pass
Component A:				
Volatiles, %	42.8	44.3	46.2	OK
Nonvolatile vehicle, %	53.7	57.7	53.8	OK
Weight per gallon, lb	7.3	8.4		
Water, %		.5	--	
Flash point, °C	35.6		36+	Yes
Component B:				
Pigment content, %	81.5	85.5	71.1	OK
Volatiles, %	8.0	8.4	13.1	OK
Nonvolatile vehicle, %	8.3	8.7	15.8	OK
Weight per gallon, lb	27.5	28.4		
Water, %		.2	--	
Flash point, °C	37.8		38	Yes
Consistency, grams	250	500	1090	No
Mixed component:				
Sag resistance, mils	12		12+	
Dry set-to-touch, hrs		2	2	Yes
Dry hard, hrs		8		
Pot life, hrs	4			Yes
Pounds per gallon	23.4	24.4		
VOC		304		

Recommendation: Accept _X_ Reject ___

Remarks: The test requirements given are for the standard formulation of this zinc epoxy primer. This formulation was modified for the product tested, and, as expected, many of the results fall outside the specification requirements. This paint is approved based on the performance characteristics of the material.

Signature: 

CERL PAINT LABORATORY TESTING REPORT

Lab Report No.: 08K101 Date: 14 November 2008

Specification: MIL-DTL-24441 F152 Type IV Contract No.:

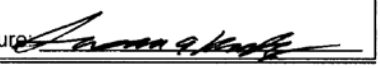
Manufacturer: Tesla NanoCoatings Limited MIPR No.:

Batch No.: a) JLH-1-012 b) JLH-1-016

Analysis:	Min	Max	Result	Pass
Component A:				
Pigment content, %	44.0	49.0	46.5	Yes
Volatiles, %	29.0	35.0	31.4	Yes
Nonvolatile vehicle, %	17.5	23.5	22.1	Yes
Water, %		1.5	--	
Coarse particles, %		0.3	--	
Consistency, grams	180	320	475	No
Pounds per gallon	11.6	12.1	11.8	Yes
Fineness of grind, NS	4		8	Yes
Flashpoint, C	35.5		36+	Yes
Component B:				
Pigment content, %	33.0	38.0	35.9	Yes
Volatiles, %	16.0	21.0	16.0	Yes
Nonvolatile vehicle, %	44.0	49.0	48.1	Yes
Water, %		0.5	--	
Coarse particles, %		0.3	--	
Consistency, grams	300	470	775	No
Pounds per gallon	10.8	11.3	10.7	Yes
Fineness of grind, NS	4		8	Yes
Flashpoint, C	37.8		38	Yes
Mixed component:				
Set-to-touch, hrs. (40 F)		3	5	No
Set-to-touch, hrs. (73 F)		3	3	Yes
Dry hard, hrs. (40 F)		24	24	Yes
Dry hard, hrs. (73 F)		8	8	Yes
Pot life, hrs. (73 F)	4		3	No
Specular gloss, 60	35			
Sag resistance, mils	12		12+	Yes
Color				
Contrast ratio (3 mils DFT)	0.98		0.96	Yes*

Recommendation: Accept __X__ Reject_____

Remarks: The epoxy intermediate coat has a higher viscosity and a shorter pot life than are required by the specification. The applicator will need to watch time and temperature to ensure the coating is applied before the viscosity becomes too high. The coating cured slowly to the set-to-touch stage at 40 degrees F., but cured hard within the required 24 hours. * Contrast ratio test chart dried to just 2 mils dry film thickness. It is assumed to pass at 3 mils.

Signature: 

Appendix E: Coating System Manufacturer's Instructions and MSDS

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ ZN Primer

Part A	JLH-1-011	Catalyst
Part B	JLH-1-017	Base

Product Information

Product Description

Teslan™ ZN Primer is a solvent-based, two component, organic nanocoating. Teslan™utilizes carbon in the form of single wall carbon nanotubes called "Buckytubes". The special nature of carbon combines with the molecular perfection of buckytubes to endow them with exceptionally high material properties such as electrical conductivity, strength, stiffness, and toughness.

- Coating provides exceptional barrier
- Provides cathodic/sacrificial if damaged
- Forms an barrier to moisture and solvents

Recommended Uses

For use over prepared blasted steel

- Locks / Dams • Refineries
- Ships • Drilling rigs • Docks • Chemical Plants
- Pipelines • Military Equipment
- As a one-coat maintenance coating or as a permanent primer for severe corrosive environments
- Ideal for application at low temperatures or service at high temperatures and/or humidity conditions
- Fresh and Salt water immersion service

Characteristics

Color:	**Dark Gray**
Finish:	**Flat**
Gloss, 60 Degree:	**35 maximum**
Mix Ratio:	**1-partsA : 2- parts B**
Pot Life (73^0):	**4-Hr minimum**
Set to Touch (73^0):	**2-Hr maximum**
Dry Hard (73^0):	**8-Hr maximum**
Flash Point, ^{0}F:	**100 minimum**
Sag, mils	**12 minimum**
Consistency, g	**150-300**
VOC, lb/gal:	**2.5 maximum**

Surface Preparation

Severe Exposure:

SSPC-SP10 Near White Blast Cleaning

Moderate Exposure:

SSPC-SP6 Commercial Blast Cleaning

Coverage Rates

Primer	Desired DFT (mils)	Spread Rate (ft^2/gal)
TESLAN™ ZN Primer	**2-6**	**200**
Theorhetical Coverage		**950/mil**

Allow for overspray and surface irregularities. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5229
www.teslanano.com

Primer ZN Tech Sheet

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ ZN Primer

Part A	JLH-1-011	Catalyst
Part B	JLH-1-017	Base

Product Information (page 2 of 2)

Mixing

Use an air-driven power mixer and keep material under constant agitation while mixing. Slowly add 1-part (Part A) into 2-parts (Part B). Adjust mixer speed to break up lumps and mix until the two components are thoroughly blended. Strain through a 35 to 60 mesh (310 to 681 microns) screen before using. For spray application, keep under low RPM agitation to prevent settling. For brush or roller application, stir frequently to prevent settling. Do not use mixed material beyond pot life limits.

Thinning

For airless spray, air spray, brush or roller thin up to 10% or 3/4 pint (380 mL) per gallon with Teslan Type II Epoxy Polyamide Thinner if temperatures are below 80°F (27°C).

Surface Temperature

Minimum 50°F (10°C) Maximum 100°F (38°C) Maximum. The surface should be dry and at least 5°F (3°C) above the dew point.

Ambient Humidity

Minimum 40% Maximum 90%

Application Equipment

Air spray

Gun	Fluid Tip	Air Cap	Hose ID	Atomizing Pressure	Pot Pressure
Devilbiss JGA or Equal	E	765 or 704	3/8 inch (9.5 mm)	40-50 psi (2.8-3.4 bar)	10-20 psi (0.7-1.4 bar)

Airless spray

Tip Orifice	Atomizing Pressure	Hose ID	Manifold Filter
0.017"-0.021" (430-535 microns) Reversible Tip	2400-3000 psi (165-207 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Clean up: Flush and clean all equipment immediately after use with Teslan Type II Epoxy Polyamide Thinner

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5226
www.teslanano.com

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN ™ ZN Primer Part A
MSDS Number:
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: TESLAN™ Primer Part A
CAS Number: Mixture
Hazard Rating: Health: 1 Fire: 2 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Paint
Trade Name:
Product Code:
DOT Hazard Class:
UN Number:
Shipping Name: SWNT /Zinc Epoxy Primer Coat
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name	CAS Number	Percent	TSCA
ZINC METAL	7440-66-6	10-30	Y
AROMATIC PETROL. DISTILL.	64742-95-6	10-30	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			
$ 1,2,4 TRIMETHYLBENZENE	95-63-6	5-10	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			

***ALL ingredients in this product are listed in the T.S.C.A. Inventory

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.
NE = not established NA = not available NR = not regulated

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN ™ ZN Primer Part A
MSDS Number:
MSDS Date: SEP-09-2008

SECTION III - PHYSICAL DATA

Form:	Liquid
Appearance/Color:	Gray
Odor:	Mild
Solubility (in water):	N
pH Value:	0
Boiling Range:	300°F (148.89°C)
Vapor Pressure (mmHg):	0 @ 0.°F (-17.78°C)
Melting Point:	0.°F (-17.78°C)
Evaporation Rate:	0.15 times slower than n-Butyl Acetate
Vapor Density:	
Partition Coefficient:	
% Volatile Weight:	23.67%
% Volatile Volume:	34.15%
Specific Gravity:	1.18656
VOC:	2.49
Molecular Weight:	
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	II
Flash Range:	130°F (54.44°C) Setaflash
Explosive Range:	1% 7%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode.

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II

EFFECTS OF OVEREXPOSURE:
EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.
SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: DO NOT induce vomiting! Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal. Drink 1-2 glasses of water to dilute.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability: This product is stable
Hazardous Polymerization: Hazardous polymerization will not occur
INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

	ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL
ZINC METAL	10mg/m^3	N/est	N/est	N/est	N/est
AROMATIC PETROL. DISTILL.	N/est	N/est	N/est	N/est	N/est
$ 1,2,4 TRIMETHYLBENZENE	25.00ppm	N/est	N/est	N/est	N/est

RESPIRATORY PROTECTION:
If workplace exposure limits are exceeded for any component (see Section II for hazardous components and exposure limits) a NISOSH/OSHA approved respirator for components listed is recommended.
VENTILATION:
Sufficient ventilation in volume and pattern, should be provided to keep air contamination below current applicable OHSA permissible exposure limit or ACGIH TLV limit.

PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Appropriate impervious clothing is recommended if prolonged or repeated contact is likely.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.
DO NOT TAKE INTERNALLY. AVOID PROLONGED INHALATION AND BODY CONTACT.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right to Know Act of 1986 and of 40 CFR 372:

Ingredient Name	CAS Number	Percent
$ 1,2,4 TRIMETHYLBENZENE	95-63-6	8.04

PROP 65 (CARCINOGEN):
WARNING: This product contains a chemical known to the state of California to cause cancer.

Ingredient Name	CAS Number	Percent
$ Lead Compound	1314-41-6	0.01

PROP 65 (TERATOGEN):
WARNING: This product contains a chemical known to the state of California to cause birth defects or other reproductive harm.

Ingredient Name	CAS Number	Percent
$ Toluene	108-88-3	0.01

PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN ™ ZN Primer Part B
MSDS Number:
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: TESLAN™ ZN Primer Part B
CAS Number: Mixture
Hazard Rating: Health: 2 Fire: 1 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Paint
Trade Name:
Product Code:
DOT Hazard Class:
UN Number:
Shipping Name: SWNT / Zinc Epoxy Primer Coat
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name	CAS Number	Percent	TSCA
AROMATIC PETROL. DISTILL.	64742-95-6	7-13	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			
MINERAL SPIRITS RULE 66	8052-41-3	5-10	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			
$ 1,2,4 TRIMETHYLBENZENE	95-63-6	3-8	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			

***ALL ingredients in this product are listed in the T.S.C.A. Inventory

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.
NE = not established NA = not available NR = not regulated

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN ™ ZN Primer Part B
MSDS Number:
MSDS Date: SEP-09-2008

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

SECTION III - PHYSICAL DATA

Form:	Liquid
Appearance/Color:	Amber
Odor:	Amine
Solubility (in water):	N
pH Value:	0
Boiling Range:	300°F (148.89°C)
Vapor Pressure (mmHg):	0 @ 0.°F (-17.78°C)
Melting Point:	0.°F (-17.78°C)
Evaporation Rate:	0.2 times slower than n-Butyl Acetate
Vapor Density:	Heavier than air
Partition Coefficient:	
% Volatile Weight:	44.34%
% Volatile Volume:	45.86%
Specific Gravity:	0.92502
VOC:	3.46
Molecular Weight:	
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	II
Flash Range:	130°F (54.44°C) Setaflash
Explosive Range:	1% 7%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode.

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN ™ ZN Primer Part B
MSDS Number:
MSDS Date: SEP-09-2008

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II
EFFECTS OF OVEREXPOSURE:
EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.
SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: DO NOT induce vomiting! Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal. Drink 1-2 glasses of water to dilute.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability:	This product is stable
Hazardous Polymerization:	Hazardous polymerization will not occur

INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

	ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL
AROMATIC PETROL. DISTILL.	N/est	N/est	N/est	N/est	N/est
MINERAL SPIRITS RULE 66	N/est	N/est	N/est	N/est	100.00ppm
$ 1,2,4 TRIMETHYLBENZENE	25.00ppm	N/est	N/est	N/est	N/est

RESPIRATORY PROTECTION:
If workplace exposure limits are exceeded for any component (see Section II for hazardous components and exposure limits) a NIOSH/OSHA approved respirator for components listed is recommended.
VENTILATION:
Sufficient ventilation in volume and pattern, should be provided to keep air contamination below current applicable OHSA permissible exposure limit or ACGIH TLV limit.

PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Appropriate impervious clothing is recommended if prolonged or repeated contact is likely.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.
DO NOT TAKE INTERNALLY. AVOID PROLONGED INHALATION AND BODY CONTACT.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right to Know Act of 1986 and of 40 CFR 372:

Ingredient Name	CAS Number	Percent

$ 1,2,4 TRIMETHYLBENZENE	95-63-6	6.11

PROP 65 (CARCINOGEN):

PROP 65 (TERATOGEN):
WARNING: This product contains a chemical known to the state of California to cause birth defects or other reproductive harm.

Ingredient Name	CAS Number	Percent
$ Toluene	108-88-3	0.01

PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ Epoxy Polyamide Intermediate Coating

Part A	JLH-1-016	Catalyst
Part B	JLH-1-012	Base

Product Information

Product Description

Teslan™ Epoxy Polyamide Intermediate coating is a solvent-based, two component, organic paint designated by Navy Formula 152 Type IV for interior or exterior use over Teslan primer coatings. The Teslan™system utilizes carbon in the form of single wall carbon nanotubes called "Buckytubes". The special nature of carbon combines with the molecular perfection of buckytubes to endow them with exceptionally high material properties such as electrical conductivity, strength, stiffness, and toughness.

- Coating provides exceptional barrier
- Provides cathodic/sacrificial if damaged
- Forms an barrier to moisture and solvents

Recommended Uses

For use over prepared blasted steel previously coated with Teslan Primers

- Locks / Dams • Refineries
- Ships • Drilling rigs • Docks • Chemical Plants
- Pipelines • Military Equipment
- Ideal for application at low temperatures or service at high temperatures and/or humidity conditions
- Fresh and Salt water immersion service

Characteristics

Color:	**White**
Finish:	**Semi-gloss**
Gloss, 60 Degree:	**35 minimum**
Mix Ratio:	**1-part A : 1- part B**
Pot Life (73^0):	**6-Hr minimum**
Set to Touch (73^0):	**3-Hr maximum**
Dry Hard (73^0):	**24-Hr maximum**
Flash Point, ^{0}F:	**100 minimum**
Sag, mils	**12 minimum**
Consistency, g	**180-245**
VOC, lb/gal:	**2.8 maximum**

Surface Preparation

Must be clean, dry, oil and grease free and free from other surface contamination applied within recoat times specified below:

Recoat	**24 - 48**	**Hours**
Extended Recoat	**1 - 15**	**Days**

Coverage Rates

Intermediate	Desired DFT (mils)	Spread Rate (ft^2/gal)
TESLAN™ Intermediate	**3-8**	**200**
Theorhetical Coverage		**1200/mil**

Allow for overspray and surface irregularities. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5229
www.teslanano.com

Intermediate Tech Sheet

NTC

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ Epoxy Polyamide Intermediate Coating

Part A	JLH-1-016	Catalyst
Part B	JLH-1-012	Base

Product Information (page 2 of 2)

Mixing

Use an air-driven power mixer and keep material under constant agitation while mixing. Slowly add 1-part (Part A) into 1-part (Part B). Adjust mixer speed to break up lumps and mix until the two components are thoroughly blended. Strain through a 35 to 60 mesh (310 to 681 microns) screen before using. Do not use mixed material beyond pot life limits.

Thinning

For airless spray, air spray, brush or roller thin up to 10% or 3/4 pint (380 mL) per gallon with Teslan Type II Epoxy Polyamide Thinner if temperatures are below 80°F (27°C).

Surface Temperature

Minimum 40°F (10°C) Maximum 100°F (38°C) Maximum. The surface should be dry and at least 5°F (3°C) above the dew point.

Ambient Humidity

Minimum 40% Maximum 90%

Application Equipment

Air spray

Gun	Fluid Tip	Air Cap	Hose ID	Atomizing Pressure	Pot Pressure
Devilbiss JGA or Equal	E	765 or 704	3/8 inch (9.5 mm)	75-100 psi (5.2-6.9 bar)	25-35 psi (1.7-2.4 bar)

Airless spray

Tip Orifice	Atomizing Pressure	Hose ID	Manifold Filter
0.015"-0.019" (380-485 microns)	4000-4800 psi (276-331 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Clean up: Flush and clean all equipment immediately after use with Teslan Type II Epoxy Polyamide Thinner

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5226
www.teslanano.com

Intermediate Tech Sheet

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part A
MSDS Number:
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: Epoxy Polyamide Intermediate Coat Part A
CAS Number: Mixture
Hazard Rating: Health: 1 Fire: 2 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Paint
Trade Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part A
Product Code:
DOT Hazard Class:
UN Number:
Shipping Name: Epoxy Intermediate Coat
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name	CAS Number	Percent	TSCA
AROMATIC PETROL. DISTILL.	64742-95-6	10-30	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			
$ 1,2,4 TRIMETHYLBENZENE	95-63-6	5-10	Y
HMIS Health: 0 Fire: 2 Reactivity: 0 PPI:			

***ALL ingredients in this product are listed in the T.S.C.A. Inventory

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.
NE = not established NA = not available NR = not regulated

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part A
MSDS Number:
MSDS Date: SEP-09-2008

SECTION III - PHYSICAL DATA

Form:	Liquid
Appearance/Color:	Amber
Odor:	Mild
Solubility (in water):	N
pH Value:	0
Boiling Range:	300°F (148.89°C)
Vapor Pressure (mmHg):	0 @ 0.°F (-17.78°C)
Melting Point:	0.°F (-17.78°C)
Evaporation Rate:	0.15 times slower than n-Butyl Acetate
Vapor Density:	
Partition Coefficient:	
% Volatile Weight:	18.5%
% Volatile Volume:	28.73%
Specific Gravity:	1.35693
VOC:	2.09
Molecular Weight:	
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	II
Flash Range:	130°F (54.44°C) Setaflash
Explosive Range:	1% 7%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode.

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II
EFFECTS OF OVEREXPOSURE:

EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.
SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: DO NOT induce vomiting! Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal. Drink 1-2 glasses of water to dilute.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability: This product is stable
Hazardous Polymerization: Hazardous polymerization will not occur
INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

	ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL
AROMATIC PETROL. DISTILL.	N/est	N/est	N/est	N/est	N/est

$ 1,2,4 TRIMETHYLBENZENE				
25.00ppm	N/est	N/est	N/est	N/est

RESPIRATORY PROTECTION:
If workplace exposure limits are exceeded for any component (see Section II for hazardous components and exposure limits) a NISOSH/OSHA approved respirator for components listed is recommended.
VENTILATION:
Sufficient ventilation in volume and pattern, should be provided to keep air contamination below current applicable OHSA permissible exposure limit or ACGIH TLV limit.

PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Appropriate impervious clothing is recommended if prolonged or repeated contact is likely.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.
DO NOT TAKE INTERNALLY. AVOID PROLONGED INHALATION AND BODY CONTACT.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right to Know Act of 1986 and of 40 CFR 372:

Ingredient Name	CAS Number	Percent
$ 1,2,4 TRIMETHYLBENZENE	95-63-6	8.04

PROP 65 (CARCINOGEN):
PROP 65 (TERATOGEN):
PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part B
MSDS Number:
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part B
CAS Number: Mixture
Hazard Rating: Health: 2 Fire: 1 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Paint
Trade Name:
Product Code:
DOT Hazard Class:
UN Number:
Shipping Name: Epoxy Intermediate Coat
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name	CAS Number	Percent	TSCA
$ BUTANOL	71-36-3	20-40	Y

HMIS Health: 3 Fire: 3 Reactivity: 0 PPI:

***ALL ingredients in this product are listed in the T.S.C.A. Inventory

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.
NE = not established NA = not available NR = not regulated

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Epoxy Polyamide Intermediate Coat Part B
MSDS Number:
MSDS Date: SEP-09-2008

SECTION III - PHYSICAL DATA

Form:	Liquid
Appearance/Color:	White
Odor:	Amine
Solubility (in water):	N
pH Value:	0
Boiling Range:	244°F (117.78°C)
Vapor Pressure (mmHg):	0 @ 0.°F (-17.78°C)
Melting Point:	0.°F (-17.78°C)
Evaporation Rate:	0.4 times slower than n-Butyl Acetate
Vapor Density:	Heavier than air
Partition Coefficient:	
% Volatile Weight:	22.17%
% Volatile Volume:	38.36%
Specific Gravity:	1.40612
VOC:	2.59
Molecular Weight:	
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	II
Flash Range:	130°F (54.44°C) Setaflash
Explosive Range:	1.4% 11.2%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode.

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II
EFFECTS OF OVEREXPOSURE:
EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.
SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: DO NOT induce vomiting! Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal. Drink 1-2 glasses of water to dilute.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability:	This product is stable
Hazardous Polymerization:	Hazardous polymerization will not occur

INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

	ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL
$ BUTANOL	N/est	N/est	N/est	N/est	N/est

RESPIRATORY PROTECTION:
If workplace exposure limits are exceeded for any component (see Section II for hazardous components and exposure limits) a NISOSH/OSHA approved respirator for components listed is recommended.
VENTILATION:
Sufficient ventilation in volume and pattern, should be provided to keep air contamination below current applicable OHSA permissible exposure limit or ACGIH TLV limit.

PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Appropriate impervious clothing is recommended if prolonged or repeated contact is likely.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.
DO NOT TAKE INTERNALLY. AVOID PROLONGED INHALATION AND BODY CONTACT.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right to Know Act of 1986 and of 40 CFR 372:

Ingredient Name	CAS Number	Percent
$ BUTANOL	71-36-3	22.32

PROP 65 (CARCINOGEN):
PROP 65 (TERATOGEN):
PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ Urethane Topcoat

Part A	JLH-1-020	Base
Part B	TB-1-057	Catalyst

Product Information

Product Description

Teslan™ Urethane Topcoat is a solvent-based, two component, organic paint designated by MIL-PRF-85285, type II for interior or exterior use over Teslan Intermediate coatings. The Teslan™system utilizes carbon in the form of single wall carbon nanotubes called "Buckytubes". The special nature of carbon combines with the molecular perfection of buckytubes to endow them with exceptionally high material properties such as electrical conductivity, strength, stiffness, and toughness.

- Coating provides exceptional barrier
- Provides cathodic/sacrificial if damaged
- Forms an barrier to moisture and solvents

Recommended Uses

For use over prepared blasted steel previously coated with Teslan Primers

- Locks / Dams • Refineries
- Ships • Drilling rigs • Docks • Chemical Plants
- Pipelines • Military Equipment
- Ideal for application at low temperatures or service at high temperatures and/or humidity conditions
- Fresh and Salt water immersion service

Characteristics

Color:	**As Specified**
Finish:	**As Specified**
Gloss, 60 Degree:	**As Specified**
Mix Ratio:	**4-parts A : 1- part B**
Pot Life (73^0):	**4-Hr minimum**
Set to Touch (73^0):	**4-Hr maximum**
Dry Hard (73^0):	**8-Hr maximum**
Flash Point, ^{0}F:	**100 minimum**
Sag, mils	**4 minimum**
Opacity	**0.95**
VOC, lb/gal:	**2.8 maximum**

Surface Preparation

Must be clean, dry, oil and grease free and free from other surface contamination applied within recoat times specified below:

Recoat	**24 - 96**	**Hours**
Extended Recoat	**4 - 7**	**Days**

Coverage Rates

Topcoat	Desired DFT (mils)	Spread Rate (ft^2/gal)
TESLAN™ Urethane Topcoat	2-4	350
Theorhetical Coverage		**1100/mil**

Allow for overspray and surface irregularities. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5229
www.teslanano.com

Teslan Topcoat Tech Sheet

NTC

TESLAN™

Revolutionary Nanocoatings for Steel

TESLAN™ Urethane Topcoat

Part A	JLH-1-020	Base
Part B	TB-1-057	Catalyst

Product Information (page 2 of 2)

Mixing

Use an air-driven power mixer and keep material under constant agitation while mixing. Slowly add 1-part (Part B) into 4-parts (Part A). Adjust mixer speed to break up lumps and mix until the two components are thoroughly blended. Strain through a 35 to 60 mesh (310 to 681 microns) screen before using. Do not use mixed material beyond pot life limits.

Thinning

For airless spray, air spray, brush or roller thin up to 10% or 3/4 pint (380 mL) per gallon with Teslan Type I Urethane Thinner if temperatures are below 80°F (27°C).

Surface Temperature

Minimum 40°F (10°C) Maximum 100°F (38°C) Maximum. The surface should be dry and at least 5°F (3°C) above the dew point.

Ambient Humidity

Minimum 40% Maximum 90%

Application Equipment

Air spray

Gun	Fluid Tip	Air Cap	Hose ID	Atomizing Pressure	Pot Pressure
Devilbiss JGA or Equal	E	765 or 704	3/8 inch (9.5 mm)	75-90 psi (5.2-6.2 bar)	10-20 psi (0.7-1.4 bar)

Airless spray

Tip Orifice	Atomizing Pressure	Hose ID	Manifold Filter
0.013"-0.017" (330-430 microns)	2700-3300 psi (186 -228 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Clean up: Flush and clean all equipment immediately after use with Teslan Type I Urethane Thinner

Tesla NanoCoatings Limited
PO Box 270
Massillon, Ohio 44646
(Tel) 3330-880-5226
www.teslanano.com

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Urethane Topcoat Part A
MSDS Number: JLH-01-020
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: TESLAN™ Urethane Topcoat Part A
CAS Number: Mixture
Hazard Rating: Health: 1 Fire: 2 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Paint
Trade Name:
Product Code: JLH-1-020
DOT Hazard Class:
UN Number:
Shipping Name: Urethane Coating
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name CAS Number Percent TSCA
(No hazardous ingredients known at this time.)

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.

NE = not established NA = not available NR = not regulated

THIS PRODUCT DOES NOT CONTAIN POLYCYCLIC ORGANIC MATERIAL SOLVENTS.

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

SECTION III - PHYSICAL DATA

Form: Liquid
Appearance/Color: White
Odor: Mild
Solubility (in water): N

pH Value:	0
Boiling Range:	0°F (-17.78°C)
Vapor Pressure (mmHg):	0 @ 0.°F (-17.78°C)
Melting Point:	0°F (-17.78°C)
Evaporation Rate:	
Vapor Density:	
Partition Coefficient:	
% Volatile Weight:	27.12%
% Volatile Volume:	40.4%
Specific Gravity:	1.34133
VOC:	.12
Molecular Weight:	
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	IC
Flash Range:	99°F (37.22°C)
	Setaflash
Explosive Range:	0%
	0%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode. Application to hot surfaces requires special precautions. During emergency conditions, overexposure to decomposition products may cause a health hazard. Symptoms may not be immediately apparent. Obtain Medical Attention.

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II
EFFECTS OF OVEREXPOSURE:
EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.

SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: Since this product may contain materials which can cause lung damage if aspirated into the lungs, the decision whether to induce vomiting must be made by a physician after careful consideration of all materials ingested.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability: This product is stable
Hazardous Polymerization: Hazardous polymerization will not occur
INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL

RESPIRATORY PROTECTION:
In outdoor or open areas with unrestricted ventilation approved chemical/mechanical filters designed to remove a combination of particulates and vapor.
VENTILATION:
Provide sufficient ventilation in volume and pattern to keep air contaminant concentration below current applicable OHSA permissible exposure limit or ACGIH TLV limit, and volatiles below lower explosive limit. Heavy solvent vapors should be removed from the lower levels of area, and all ignition sources (non-explosion proof equipment) should be eliminated if flammable

mixtures will be encountered. Remove decomposition products formed during welding or flame cutting of surfaces coated with this product. For baking finishes - vent vapors emitted on heating.
PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Normal protective clothing. Wash contaminated clothing before reuse.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
PROP 65 (CARCINOGEN):
PROP 65 (TERATOGEN)
PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

Tesla NanoCoatings Limited **Material Safety Data Sheet**

MSDS Name: TESLAN™ Urethane Hardener Part B
MSDS Number: TB-1-047
MSDS Date: SEP-09-2008

SECTION I - PRODUCT AND COMPANY INFORMATION

Product Name: TESLAN™ Urethane Hardener Part B
CAS Number: Mixture
Hazard Rating: Health: 2 Fire: 1 Reactivity: 1 PPI:

Company Identification: Tesla NanoCoatings Limited
1311 20th Street SW
Massillon, OH 44647

Contact: Todd Hawkins
Telephone: (330) 417-3550
Emergency Phone (24 Hour): (330)-417-3550

Product Class: Catalyst
Trade Name:
Product Code: TB-1-047
DOT Hazard Class:
UN Number:
Shipping Name: Urethane Isocyanate Hardener
Technical Name:

Additional Information

SECTION II - INGREDIENT AND HAZARD INFORMATION

Ingredient Name	CAS Number	Percent	TSCA

(No hazardous ingredients known at this time.)

ADDITIONAL INFORMATION

SECTION 313 SUPPLIER NOTIFICATION: THIS PRODUCT MAY CONTAIN TOXIC CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT TO KNOW ACT OF 1986 AND 40 CFR 372 (NOTED BY THE $ SYMBOL)

CAUTION: This product may become a dust nuisance when removed by sanding, abrading or sandblasting. Dust masks should be worn during these operations.

NE = not established NA = not available NR = not regulated

THIS PRODUCT DOES NOT CONTAIN POLYCYCLIC ORGANIC MATERIAL SOLVENTS.

ALL COMPONENTS OF THIS MIXTURE ARE LISTED ON THE TSCA INVENTORY.

SECTION III - PHYSICAL DATA

Form: Liquid
Appearance/Color: Clear
Odor: Solvent
Solubility (in water): N

pH Value:	N/A
Boiling Range:	220°F 104.44°C)
Vapor Pressure (mmHg):	15 @ 68.°F 20°C)
Melting Point:	N/A
Evaporation Rate:	Unavailable
Vapor Density:	Heavier than air
Partition Coefficient:	
% Volatile Weight:	11%
% Volatile Volume:	11%
Specific Gravity:	1.12777
VOC:	1
Molecular Weight:	500
Heavy Elements (ppm):	0

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flammability Class:	II
Flash Range:	135°F (57.22°C) Setaflash
Explosive Range:	1% 7%

EXTINGUISHING MEDIA:

Carbon Dioxide---Dry Chemical---Foam---Water Fog
Use water for cooling material stored in vicinity of fire.
SPECIAL FIREFIGHTING PROCEDURES:
Use self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. Wear protective clothing.
UNUSUAL FIRE & EXPLOSION HAZARDS:
Vapors are heavier than air and may travel along the ground to an ignition source some distance from material handling point. Ignition sources include pilot lights, smoking, heaters, electric motors, sparks from electrical switches and static discharges.
CAUTION: Never use cutting torch on empty containers! Residual solvent vapor in empty container may explode. Application to hot surfaces requires special precautions. During emergency conditions, overexposure to decomposition products may cause a health hazard. Symptoms may not be immediately apparent. Obtain Medical Attention.

SECTION V - HEALTH HAZARD DATA

Route	Species	Exposure and Dose

PERMISSIBLE EXPOSURE LEVEL:
Refer to Section II
EFFECTS OF OVEREXPOSURE:
EYES: Can cause redness, irritation, swelling and blurred vision.
SKIN: Prolonged or repeated contact can cause moderate irritation, defatting, dermatitis.
BREATHING: Excessive inhalation of vapors and/or spray mist can cause respiratory irritation, dizziness, weakness, fatigue nausea, headache, unconsciousness and even asphyxiation.

SWALLOWING: Can cause gastrointestinal irritation,nausea, vomiting and diarrhea; aspiration of material into the lungs can cause chemical pneumonitis which can be fatal.
FIRST AID:
EYES: Flush with large amounts of water for 15 minutes. Lift eyelids occasionally, get prompt medical attention.
SKIN: Wash thoroughly with soap and water, remove contaminated clothing promptly; wash clothing before reuse. Consult a physician if irritation persists.
SWALLOWING: DO NOT induce vomiting! Keep person warm, quiet and get medical attention. Aspiration of material into the lungs due to vomiting can cause chemical pneumonitis which can be fatal. Drink 1-2 glasses of water to dilute.
INHALATION: Move affected person to fresh air. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Keep person warm, quiet, and get medical attention. Consult a physician.

SECTION VI - REACTIVITY DATA

Stability: This product is stable
Hazardous Polymerization: Hazardous polymerization will not occur
INCOMPATIBILITY :
Avoid contact with strong oxidizers (e.g. nitric acid)
CONDITIONS TO AVOID:
Keep away from heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS:
May form carbon monoxide and dioxide, various hydrocarbons, etc.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED SMALL SPILL:
Absorb liquid with rags, floor absorbent, vermiculite or other absorbent material and transfer to hood.
LARGE SPILL: Eliminate all ignition sources---dike area of spill to prevent spreading---ventilate area if indoors---pump liquid into salvage tank---remaining liquid may be taken up with sand, floor absorbent or other absorbent material and shoveled into containers---prevent run-off to sewers and bodies of water--notify proper authorities as required by local, state and federal regulations.
WASTE DISPOSAL METHOD:
Dispose of in accordance with federal, state and local regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Occupational Exposure Limits

ACGIH TLV	ACGIH TLV-C	ACGIH STEL	OSHA STEL	OSHA PEL

RESPIRATORY PROTECTION:
If workplace exposure limits are exceeded for any component (see Section II for hazardous components and exposure limits) a NISOSH/OSHA approved respirator for components listed is recommended.
VENTILATION:
Sufficient ventilation in volume and pattern, should be provided to keep air contamination below current applicable OHSA permissible exposure limit or ACGIH TLV limit.

PROTECTIVE GLOVES:
Wear resistant gloves such as: nitrile rubber
EYE PROTECTION:
Chemical splash goggles in compliance with OSHA regulations are advised; however, OSHA regulations also permit other types of safety glasses. (Consult your safety equipment supplier)
OTHER PROTECTIVE EQUIPMENT:
Appropriate impervious clothing is recommended if prolonged or repeated contact is likely.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:
Do not drop containers. Avoid heat, sparks, and open flame. Store large quantities only in buildings designed to comply with OSHA 1910.106. Never use pressure to empty. Avoid breathing sanding dust. Do not handle until the manufacturers safety precautions have been read and understood.
OTHER PRECAUTIONS:
The information accumulated herein is believed to be accurate but is not warranted to be whether originating with the company or not. Recipients are advised to confirm in advance of need that the information is current, applicable, and suitable to their circumstances.

SECTION X - ADDITIONAL REGULATORY INFORMATION

SARA TITLE III SECTION 313:
PROP 65 (CARCINOGEN):
PROP 65 (TERATOGEN)
PROP 65 (BOTH CARCINOGEN AND TERATOGEN) :

Appendix F: Sealant Specifications, Manufacturer's Instructions, and MSDS

Construction

Product Data Sheet
Edition 8.2003
Identification no. 431
Sikaflex-1a

Sikaflex®-1a

One part polyurethane, elastomeric sealant/adhesive

Description

Sikaflex-1a is a premium-grade, high-performance, moisture-cured, 1-component, polyurethane-based, non-sag elastomeric sealant. Meets Federal specification TT-S-00230C, Type II, Class A. Meets ASTM C-920, Type S, Grade NS, Class 25, use T, NT, O, M, G, I; Canadian standard CAN/CGSB 19.13-M87.

Where to Use

- Designed for all types of joints where maximum depth of sealant will not exceed ½ in.
- Excellent for small joints and fillets, windows, door frames, reglets, flashing, and many construction adhesive applications.
- Suitable for vertical and horizontal joints; readily placeable at 40°F.
- Has many applications as an elastic adhesive between materials with dissimilar coefficients of expansion.
- Submerged conditions, such as canal and reservoir joints.

Advantages

- Eliminates time, effort, and equipment for mixing, filling cartridges, pre-heating or thawing, and cleaning of equipment.
- Fast tack-free and final cure times.
- High elasticity - cures to a tough, durable, flexible consistency with exceptional cut and tear-resistance.
- Stress relaxation.
- Excellent adhesion - bonds to most construction materials without a primer.
- Excellent resistance to aging, weathering.
- Proven in tough climates around the world.
- USDA-approved.
- Odorless, non-staining.
- Jet fuel resistant.
- NSF-approved for potable water contact.
- Urethane-based; suggested by EPA for radon reduction.
- Paintable with water-, oil- and rubber-based paints.
- Capable of ±25% joint movement.

Typical Data *(Material and curing conditions @ 73°F (23°C) and 50% R.H.)*

Shelf Life
10.3 fl. oz. cartridges 15 months in original unopened packaging
20 fl. oz. uni-pac sausages 15 months in original unopened packaging
5 gal. pail 9 months in original unopened packaging
55 gal. pail 9 months in original unopened packaging

Storage Conditions Store at 40°-95°F (4°-35°C). Condition material to 65°-75°F before using.

Colors White, colonial white, aluminum gray, limestone, black, dark bronze, capitol tan. Special architectural colors on request.

Application Temperature 40° to 100°F. Sealant should be installed when joint is at mid-range of its anticipated movement.

Service Range -40° to 170°F

Curing Rate

Tack-free time	4 hours (TT-S-00230C)
Tack-free to touch	3 hours
Final cure	4 to 7 days

Tear Strength (ASTM D-624) 50 lb./in.

Shore A Hardness (ASTM D-2240) 21 day 40±5

Tensile Properties (ASTM D-412)

21 day	Tensile Stress		200 psi (1.37MPa)
	Elongation at Break		500%
	Modulus of Elasticity	25%	35 psi (0.24 MPa)
		50%	60 psi (0.41 MPa)
		100%	85 psi (0.59 MPa)

Adhesion in Peel (TT-S-00230C, ASTM C 794)

Substrate	Peel Strength	Adhesion Loss
Concrete	20 lb.	0%
Aluminum	20 lb.	0%
Glass	20 lb.	0%

Weathering Resistance Excellent

Chemical Resistance Good resistance to water, diluted acids, and diluted alkalines. Consult Technical Service for specific data.

Construction

Coverage 10.3 fl. oz. cartridge seals 12.4 lineal ft. of 1/2 x 1/4 in. joint. 20 fl. oz. uni-pac sausage seals 24 lineal ft. of 1/2 x 1/4 in. joint.

Packaging Disposable 10.3 fl. oz., moisture-proof composite cartridges, 24/case; and uni-pac sausages, 20 fl. oz., 20/carton.

Linear Feet of Sealant per Gallon

Width \ Depth	¼	½	¾	1	1¼	1½
¼	308.0					
½	154.0	77.0				
¾	102.7	51.3	34.2			
1	77.0	38.5	25.7	19.3		
1¼	61.6	30.8	20.5	15.4	12.3	
1½	51.3	25.7	17.1	12.8	10.3	8.6

How to Use

Surface Preparation Clean all surfaces. Joint walls must be sound, clean, dry, frost-free, and free of oil and grease. Curing compound residues and any other foreign matter must be thoroughly removed. Install bond breaker tape or backer rod to prevent bond at base of joint.

Priming Priming is not usually necessary. Most substrates only require priming if testing indicates a need or where sealant will be subjected to water immersion after cure.

Consult Sikaflex Primer Technical Data Sheet or Technical Service for additional information on priming.

Application Recommended application temperatures: 40°-100°F. For cold weather application, condition units at approximately 70°F; remove prior to using.

For best performance, Sikaflex-1a should be gunned into joint when joint slot is at mid-point of its designed expansion and contraction.

Place nozzle of gun into bottom of the joint and fill entire joint. Keep the nozzle in the sealant, continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment.

Avoid overlapping of sealant to eliminate entrapment of air. Tool as required. Joint dimension should allow for 1/4 inch minimum and 1/2 inch maximum thickness for sealant. Proper design is 2:1 width to depth ratio.

For use in horizontal joints in traffic areas, the absolute minimum depth of the sealant is 1/2 in. and closed cell backer rod is recommended. Tool as necessary, dry or with clean water.

Limitations

- Allow 1-week cure at standard conditions when using Sikaflex-1a in total water immersion situations and prior to painting.
- When overcoating with water, oil and rubber based paints, compatibility and adhesion testing is essential.
- Avoid exposure to high levels of chlorine. (Maximum continuous level is 5 ppm of chlorine.)
- Maximum depth of sealant must not exceed 1/2 in.; minimum depth is 1/4 in.
- Maximum expansion and contraction should not exceed 25% of average joint width.
- Do not cure in the presence of curing silicone sealants.
- Avoid contact with alcohol and other solvent cleaners during cure.
- Do not apply when moisture-vapor-transmission condition exists from the substrate as this can cause bubbling within the sealant.
- Some minimal surface skinning of product may be present in bulk packaging (pails, drums) with in its shelf life. Cut and discard cured material to expose the uncured product that still may be used.
- Use opened cartridges and uni-pac sausages the same day.
- When applying sealant, avoid air-entrapment.
- Since system is moisture-cured, permit sufficient exposure to air.
- White color tends to yellow slightly when exposed to ultraviolet rays.
- Light colors can yellow slightly if exposed to direct gas fired heating elements prior to formation of initial skin.
- The ultimate performance of Sikaflex-1a depends on good joint design and proper application with joint surfaces properly prepared.
- The depth of sealant in horizontal joints subject to traffic is 1/2 in.
- Do not tool with detergent or soap solutions.

Caution

Irritant Keep away from open flames and high heat. Contains xylene; avoid breathing vapors. Use with adequate ventilation.

Combustible Avoid skin and eye contact. Use of NIOSH approved organic vapor respirator, safe and chemical-resistant gloves recommended. Remove contaminated clothing and shoes.

First Aid In case of skin contact, wash thoroughly with soap and water. For eye contact, flush immediately with plenty of water for at least 15 minutes; contact physician. Wash clothing before re-use. Discard contaminated shoes.

Clean Up Uncured material can be removed with approved solvent. Cured material can only be removed mechanically. For spillage, collect, absorb, and dispose of in accordance with current, applicable local, state, and federal regulations.

KEEP CONTAINER TIGHTLY CLOSED — KEEP OUT OF REACH OF CHILDREN
NOT FOR INTERNAL CONSUMPTION — FOR INDUSTRIAL USE ONLY
CONSULT MATERIAL SAFETY DATA SHEET FOR MORE INFORMATION

Visit our website at www.sikausa.com **1-800-933-SIKA NATIONWIDE**

Regional Information and Sales Centers. For the location of your nearest Sika sales office, contact your regional center.

Sika Corporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-933-6225

Sika Canada Inc.
601 Delmar Avenue
Pointe Claire
Quebec H9R 4A9
Phone: 514-697-2610
Fax: 514-694-2792

Sika Mexicana S.A. de C.V.
Carretera Libre Celaya Km. 8.5
Corregidora, Queretaro
C.P. 76920 A.P. 136
Phone: 52 42 25 0122
Fax: 52 42 25 0537

MATERIAL SAFETY DATA SHEET

Sikaflex® 1A (All Colors)

HMIS

HEALTH	*2
FLAMMABILITY	1
REACTIVITY	0
PERSONAL PROTECTION	C

1. Product And Company Identification

Supplier
Sika Corporation
201 Polito Ave
Lyndhurst, NJ 07071

Company Contact: EHS Department
Telephone Number: 201-933-8800
FAX Number: 201-933-9379
Web Site: www.sikausa.com

Manufacturer
Sika Corporation
201 Polito Ave
Lyndhurst, NJ 07071

Company Contact: EHS Department
Telephone Number: 201-933-8800
FAX Number: 201-933-9379
Web Site: www.sikausa.com

Supplier Emergency Contacts & Phone Number
CHEMTREC: 800-424-9300
INTERNATIONAL: 703-527-3887

Manufacturer Emergency Contacts & Phone Number
CHEMTREC: 800-424-9300
INTERNATIONAL: 703-527-3887

Issue Date: 08/09/2007

Product Name: Sikaflex® 1A (All Colors)
CAS Number: Not Established
Chemical Family: Polyurethane
MSDS Number: 4016
Product Code: 0431543

2. Composition/Information On Ingredients

Ingredient Name	CAS Number		Percent Of Total Weight
POLYISOCYANATE PREPOLYMER	Trade Secret		
XYLENE (MIXED ISOMERS)	1330-20-7	<	4

3. Hazards Identification

Eye Hazards
Causes eye irritation.

Skin Hazards
May cause skin irritation. Prolonged and/or repeated skin contact may cause an allergic reaction/sensitization.

Ingestion Hazards
May be harmful if swallowed.

Inhalation Hazards
May cause nose, throat, and lung irritation. May cause an allergic respiratory reaction / sensitization after prolonged or repeated contact. Reports have associated repeated and prolonged exposure to some of the

MATERIAL SAFETY DATA SHEET

Sikaflex® 1A (All Colors)

3. Hazards Identification - Continued

Inhalation Hazards - Continued

chemicals in this product with permanent brain, liver, kidney, and Central Nervous System damage. Headaches and dizziness may result.

4. First Aid Measures

Eye

In case of contact, hold eyelids apart and immediately flush eyes with plenty of tepid water for at least 15 minutes. Get medical attention immediately if irritation develops and persists.

Skin

In case of contact, immediately flush skin with soap and plenty of tepid water for at least 15 minutes. Get medical attention immediately if irritation (redness, rash, blistering) develops and persists.

Ingestion

If victim is fully conscious do not induce vomiting, give one or two cups of water or milk to drink. Call a physician or a poison control center immediately.

Inhalation

Remove to fresh air. If not breathing, give artificial respiration, seek medical attention.

5. Fire Fighting Measures

Flash Point: N/A °F
Flash Point Method: Solid per ASTM D4359
Autoignition Point: N/AV °F
Lower Explosive Limit: N/AV
Upper Explosive Limit: N/AV

Fire And Explosion Hazards

During a fire, irritating and/or toxic gases and aerosols from the decomposition/combustion products may be present.

Extinguishing Media

In case of fire, use water spray (fog) foam, dry chemical, or CO2.

Fire Fighting Instructions

In the event of a fire, firefighters should wear full protective clothing and NIOSH-approved self-contained breathing apparatus with a full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Avoid release to the environment. Use appropriate Personal Protective Equipment (PPE). Contain spill and collect with absorbent material and transfer into suitable containers. Do not flush to sewer or allow to enter waterways. Ventilate enclosed area.

7. Handling And Storage

Handling And Storage Precautions

Keep out of reach of children. Store in a cool, dry, well ventilated area. Keep containers tightly closed.

Handling Precautions

Do not smoke. Use only in well ventilated areas. Condition to 65-85F before using. Use only with ventilation sufficient to reduce potential exposures (air borne levels of dust, fumes, vapors, etc.) to below recommended exposure limits.

Storage Precautions

Do not store near excessive heat. Store in tightly closed containers and protect from moisture and foreign

MATERIAL SAFETY DATA SHEET

Sikaflex® 1A (All Colors)

7. Handling And Storage - Continued

Storage Precautions - Continued

material. Ideal storage temperature is less than 75F. If maximum storage temperature is exceeded, material may prematurely polymerize without hazard.

Work/Hygienic Practices

Wash thoroughly with soap and water after handling.

8. Exposure Controls/Personal Protection

Engineering Controls

Use of a system of local and/or general exhaust is recommended to keep employee below applicable exposure limits. Refer to the current edition of "Industrial Ventilation: A Manual of Recommended Practice" published by the American Conference of Governmental Industrial Hygienists for information on the design, installation, use, and maintenance of exhaust systems.

Eye/Face Protection

Safety glasses with side shields or goggles.

Skin Protection

Chemical-resistant gloves. Lab coat or other work clothing to prevent skin exposure (Long sleeve shirt and long pants). Launder before reuse.

Respiratory Protection

A respirator protection program that meets 29 CFR 1910.134 requirement must be followed whenever workplace conditions warrant a respirator's use. In areas where the Permissible Exposure Limits are exceeded, use a properly fitted NIOSH-approved respirator.

Other/General Protection

Wash thoroughly after handling.

Ingredient(s) - Exposure Limits

XYLENE (MIXED ISOMERS)
ACGIH TLV-STEL 150 ppm
ACGIH TLV-TWA 100 ppm
OSHA PEL-TWA 100 ppm

9. Physical And Chemical Properties

Appearance

Paste (solid) in various colors

Odor

Aromatic odor

Chemical Type: Mixture
Physical State: Solid
Melting Point: N/AV °F
Boiling Point: N/AV °F
Specific Gravity: 1.4 grams/cm3
Percent VOCs: < 4%
Packing Density: 11.5 - 12.0 pounds /gallon
Vapor Pressure: N/AV
Vapor Density: > Air
Solubility: N/AV
Evaporation Rate: Slower than ether
VOC Content: < 40 grams / liter (EPA Method 24)

MATERIAL SAFETY DATA SHEET

Sikaflex® 1A (All Colors)

10. Stability And Reactivity

Stability: Stable
Hazardous Polymerization: Will not occur

Conditions To Avoid (Stability)
Open flame

Incompatible Materials
Water, Alcohol, Amines

Hazardous Decomposition Products
Carbon Dioxide, Carbon Monoxide, and Oxides of Nitrogen, Smoke, Fumes

Conditions To Avoid (Polymerization)
None known

11. Toxicological Information

Conditions Aggravated By Exposure
Eye disease, skin disorders and allergies, chronic respiratory conditions.

12. Ecological Information

No Data Available...

13. Disposal Considerations

Dispose in accordance with applicable federal, state and local government regulations. Waste generators must determine whether a discarded material is classified as a hazardous waste. USEPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.

14. Transport Information

Proper Shipping Name
Not regulated by the USDOT.

15. Regulatory Information

U.S. Regulatory Information
All ingredients of this product are listed or are excluded from listing under the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

SARA Hazard Classes
Acute Health Hazard
Chronic Health Hazard

SARA Title III - Section 313 Supplier Notification
This product contains the following toxic chemicals that are subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372.

XYLENE (MIXED ISOMERS) (1330-20-7) <4 %

This information must be included on all MSDSs that are copied and distributed for this material.

Ingredient(s) - U.S. Regulatory Information
XYLENE (MIXED ISOMERS)
SARA Title III - Section 313 Form "R"/TRI Reportable Chemical
SARA - Acute Health Hazard
SARA - Chronic Health Hazard

MATERIAL SAFETY DATA SHEET

Sikaflex® 1A (All Colors)

15. Regulatory Information - Continued

Ingredient(s) - U.S. Regulatory Information - Continued

SARA - Fire Hazard

Ingredient(s) - State Regulations

XYLENE (MIXED ISOMERS)
- New Jersey - Workplace Hazard
- New Jersey - Environmental Hazard
- New Jersey - Special Hazard
- Pennsylvania - Workplace Hazard
- Pennsylvania - Environmental Hazard
- Massachusetts - Hazardous Substance
- New York City - Hazardous Substance

16. Other Information

HMIS Rating
Health: *2
Fire: 1
Reactivity: 0
PPE: C

Revision/Preparer Information
MSDS Preparer: EHS Department
MSDS Preparer Phone Number: 201 933 8800
This MSDS Supercedes A Previous MSDS Dated: 12/11/2006

Disclaimer

The information contained in this Material Safety Data Sheet applies only to the actual Sika Corporation ("Sika") product identified and described herein. This information is not intended to address, nor does it address the use or application of the identified Sika product in combination with any other material, product or process. All of the information set forth herein is based on technical data regarding the identified product that Sika believes to be reliable as of the date hereof. Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's current Technical Data Sheet, product label and Material Safety Data Sheet for each Sika product, which are available at web site and/or telephone number listed in Section 1 of this MSDS.

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All sales of Sika products are subject to its current terms and conditions of sale available at www.sikacorp.com or 201-933-8800.

Sika Corporation

Appendix G: Blast Media Certification and MSDS

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

IN REPLY REFER TO

4123
Ser 03R42/809

OCT 30 1996

Mobile Abrasives
Attn: Mr. E. Serda
Pinto Island
400 Dunlop Drive
P.O. Box 1156
Mobile, AL 36633-1156

Dear Sir:

We are in receipt of your letter of 10 September 1996 advising use that your company Clark Sand Company, Inc. has sold all of its assets relating to its operations in Mobile, Alabama to Mobile Abrasives formerly known as "Fairmont Abrasives".

Therefore, effective the date of this letter, qualification approval for your MIL-A-22262A(SH)/Amendment-2 "Black Blast" abrasive blasting media is hereby transferred to the product now owned and manufactured by Mobile Abrasives, Pinto Island, 400 Dunlap Drive, Mobile, Alabama. By your letter, your firm certifies that the product to be manufactured by Mobile Abrasives will be manufactured under the same conditions as originally qualified., i.e. same processes, materials, manufacturers designation and at the same manufacturing plant. The product transferred under this letter is still subject to the conditions printed on the reverse side of this page.

QPL-22262 is be modified to reflect this change.

Any questions regarding this matter should be directed to Joann Starks at (703) 602-9137, Ext. 123.

Sincerely,

CHERYL A. TURNER
ENGINEERING STANDARDS DIVISION

Copy to:
NMQAO
GSA
DCMC, Birmingham

904-835-7715

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

4123 IN REPLY REFER TO
03R42/34

JAN 26 1996

Clark Sand Company, Inc.
Attn: Edward Serda
P.O. Box 4267
Pensacola, FL 32507

Dear Mr. Serda:

We are in receipt of the qualification test results conducted on your **"Black Blast"** abrasive. The results were forwarded to this Command by the Defense Contract Management Area Operations, DCMAO, Birmingham. Report Number M5-05489, which shows results of qualification testing conducted at Savannah Laboratories & Environmental Services, Inc., indicates that your product conforms to the test requirements of MIL-A-22262B(SH) and Amendment-1.

We are also in receipt of a toxicity assessment of your **"Black Blast"** abrasive from the Navy Environmental Health Center, (NEHC), enclosure (1). Based on NEHC's letter report 6270, Ser IHDrej/03553, 23 January 1996, your abrasive can be safely used for its intended purpose, provided precautions outlined in enclosure (1) are strictly followed. **Clark Sand must notify users about this product and all of the precautions that are noted in NEHC's report. Navy and other users of this product must adhere to the latest revisions of OPNAVINSTs 4110.2; 5100.23 and 5100.19.**

Effective the date of this letter, qualification approval is granted to your **"Black Blast"** abrasive to be manufactured at your plant located at 400 Dunlap Drive, Pinto Island, Mobile, AL 36652. This approval is subject to the conditions printed on the reverse side of the page. Your product will appear on the next issue of QPL-22262 as shown below:

GOVERNMENT DESIGNATION	MANUFACTURER'S DESIGNATION	TEST OR QUALIFICATION REFERENCE	MANUFACTURER'S NAME & ADDRESS
	Black Blast	Savannah Lab. Rpt. M5-05489, NEHC Ltr Rpt. 6270, Ser IHDrej/03553	Clark Sand Co., Inc. P.O. Box 4267 Pensacola, FL 32507 **Plant:** 400 Dunlap Drive Pinto Island Mobile, AL 36652

Opta Minerals Inc.

Your one source

Material Safety Data Sheet

SECTION 1 – PRODUCT IDENTIFICATION & USE:

Black Blast

CHEMICAL NAME AND SYNONYMS: Crushed Coal Slag

MSDS NO: 358-3

MANUFACTURER AND SUPPLIER:

Opta Minerals
407 Parkside Drive
Waterdown, Ontario
L0R2H0
Tel: 905-689-6661
Emergency: 905-689-6661, Ext: 222

MATERIAL IDENTIFICATION AND USE

This material is a shiny, black, granular aggregate for use as a blasting media. This product contains no free crystalline silica. Note: This MSDS covers many products and individual physical and chemical properties will vary. Consult individual Technical Data Sheet's for specifics.

SECTION 2 – HAZARDOUS INGREDIENTS

The approximate element composition of this material is as follows:

Ingredients	Chemical formula by weight	Typical %	CAS #
Silicon Dioxide (total)	SiO_2 (total)	~46.5	60676-86-0
Aluminum Oxide	AL_2O_3	~22.5	1344-28-1
Iron Oxide	Fe_2O_3	~19.0	1309-37-1
Calcium Oxide	CaO	~5.5	1305-78-8
Magnesium Oxide	MgO	~1.0	1309-48-4
Titanium Dioxide	TiO_2	~1.0	13463-67-7
Crystalline Silica	SiO_2 (crystalline)	<0.1	14808-60-7

SECTION 3 – PHYSICAL DATA

APPEARANCE:	Solid, angular granules. Shiny black colour.
ODOUR:	No appreciable odour.
SOLUBILITY IN WATER (%):	Insoluble.
MELTING POINT:	Not available.
pH:	Not available.

SECTION 4 – FIRE AND EXPLOSION DATA

FLAMMABILITY: No.
EXTINGUISHING MEDIA: Not applicable.
SPECIAL FIRE FIGHTING PROCEDURES: Not applicable.
UNUSUAL FIRE/EXPLOSION HAZARDS: Not applicable.
The product will not burn or explode.

SECTION 5 - REACTIVITY DATA

PRODUCT STABILITY: Stable.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Not applicable.
INCOMPATIBILITY: Not applicable.
HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS: Not applicable.

SECTION 6 - TOXICOLOGICAL PROPERTIES

EYE CONTACT: May cause irritation due to presence of "foreign object".
SKIN CONTACT: Possible skin irritation.
INHALATION:
EFFECTS OF ACUTE EXPOSURE: Exposure may cause irritation to nose, throat and lungs.
EFFECTS OF CHRONIC EXPOSURE: Exposure may cause irritation to nose, throat and lungs.
INGESTION: May cause irritation.
OCCUPATIONAL EXPOSURE LIMITS: The following Threshold Limit Values (TLV's) refer to airborne concentrations of substances. The potential hazard of solid particles depends on particle size, which is expressed in three forms:

Inhalable (< 100 m) – when deposited anywhere in the respiratory tract
Thoracic (< 25 m) – when deposited anywhere within the lung airways and the gas-exchange region
Respirable (< 10 m) – when deposited in the gas-exchange region

Substance	C.A.S. No.	PEL	TWA	STEL/C	Critical Effect(s)
PNOC [1]	Inhalable	15	10	-	Lung
	Respirable	5	3	-	Lung
Fe_2O^3 (Iron Oxide)	1309-37-1	10	5	-	Pneumoconiosis
AL_2O^3 (Aluminum Oxide)	1344-28-1	15	10	-	Lung; irritation
CaO (Calcium Oxide)	1305-78-8	5	2	-	Irritation
MgO (Magnesium Oxide)	1309-48-4	15	10	-	Irritation; metal fume fever
TiO_2 (Titanium Dioxide)	13463-67-7	15	10	-	Lung

[1] Particulates (Insoluble) Not Otherwise Classified

OSHA PEL – Permissible Exposure Limit (mg/m^3)
ACGIH TWA – Time Weighted Average (mg/m^3)
STEL/C – Short-term Exposure Limit / Ceiling (mg/m^3)
In other jurisdiction, please consult appropriate occupational exposure regulations.
Reference: 1999 TLV's and BEI's Threshold Limit Values for Chemical Substances and Physical Agents Biological Exposure Indices

SECTION 7 - PREVENTATIVE MEASURES

EYE PROTECTION: Safety goggles or glasses, as required by nature of task(s) being performed.
SKIN PROTECTION: Impervious gloves recommended and other clothing as required by nature of work being done.
VENTILATION: Use adequate ventilation and dust collection.
RESPIRATORY PROTECTION: The following chart specifies the types of respirators to be used based on airborne concentrations of respirable crystalline silica. This chart has been provided as a guide for protection of personnel that may be exposed to airborne concentrations of any particulate matter.

SECTION 7 - PREVENTATIVE MEASURES (continues)

Airborne Concentration (Respirable Free Silica)	**Type of Respirator Required**
< or equal to 10 X TWAEV	Half-mask particulate respirator with N-, R-, or P- series filter and 95, 99, or 100% efficiency.
< or equal to 25 X TWAEV	Powered air purifying respirator equipped with a hood or helmet, and any type of particulate filter; or supplied air respirator equipped with a hood or helmet and operated in a continuous flow mode.

TWAEV – time-weighted average exposure value

Where applicable, respirators should be fitted, maintained, and cleaned in accordance with the regulations made under the Occupational Health and Safety Act.

OTHER PROTECTIVE EQUIPMENT:
As required by nature of work being done.

LEAKS AND SPILLS: Avoid breakage of bagged material or spills of bulk material. Do not dry sweep, use a dustless system (vacuum) for clean up so that airborne dust does not exceed the permissible exposure limit.

WASTE DISPOSAL INFORMATION:
Dispose in accordance with federal, state or local regulations. Material contaminated in use may have special disposal requirements. Dispose in accordance with federal, state or local regulations

HANDLING PROCEDURES AND EQUIPMENT:
Use adequate ventilation and dust collection. Do not permit dust to collect on walls, floors, ledges, machinery, or equipment. Use dustless system (vacuum) for handling, storage and clean up so that airborne dust does not exceed the permissible exposure limit.

STORAGE REQUIREMENTS: No special storage procedures required. Avoid dust generation when handling.

SECTION 8 - FIRST AID MEASURES

SKIN CONTACT: Wash with soap and water.
EYE EXPOSURE: Flush with water and seek medical advice if irritation persists.
INGESTION: Seek immediate medical aid.
INHALATION: Remove to fresh air. If breathing difficulty is encountered, seek medical aid.

SECTION 9 - PREPARATION DATE OF MSDS

The MSDS was prepared from information provided by raw material suppliers to Opta Minerals.

DATE ISSUED: October 13, 2005
CONTACT: Operations Supervisor
Quality Control Coordinator

For non-emergency questions, please contact your sales person.
General inquiries may be directed to 905-689-6661.

Appendix H: Elcometer 456 Type II Coating Thickness Gauge

elcometer 456 Dry Film Thickness Gauge

The new version of the **Elcometer 456 Coating thickness Gauge** now benefits from a larger display for easy data viewing and a simple calibration feature to make testing even quicker.

The **Elcometer 456 also features *Bluetooth*® wireless technology** for fast data transfer to the new **ElcoMaster Software™**, ideal for easy report generation and archiving of readings. The *Bluetooth*® feature also allows the Elcometer 456 to connect to PDA's and mobile phones for instant reporting and e-mailing from the field.

This No 1 Seller in the market is available in any combination of Basic, Standard, and Top functionality; together with Integral (built in) or an extensive range of separate plug in probes. With such an extensive range of gauge options, there is an Elcometer 456 to meet your specific application needs.

Features

- **Fast, accurate & easy to use** Paint & Coating Thickness Gauge New Model Features a larger display screen
- **Greater** than **60 readings per minute** for fast results.
- **Unrivalled accuracy and repeatability** for the ultimate hand-held performance.
- Available as an **integral or plug-in separate probe** version for total versatility.
- **Full, menu driven, graphics display** for ease of use with calibration & on screen instructions in 25 languages.
- 3 versions available - **basic, standard & top** - to meet your specific requirements.
- **Ergonomic** in styling for the ultimate in hand held comfort.
- **Calibration Foils** included. **ISO, NBS** (with traceable calibration report) and **working foils** available. Provides traceable accuracy for calibration adjustment carried out on the User's own substrate.
- **Full statistical data display** allows the user to view all or any statistics from Number of readings, Mean, Standard Deviation, Highest & Lowest Reading and Coefficient of Variation
- **One Year Guarantee on Unit** and three month guarantee on probes
- **Portable:** Hand held battery powered instrument. (comparable to the size of a computer mouse)
- **Memory:** Standard and Top gauges offer secure data storage.
- ***Bluetooth*®:** Wireless connectivity from the gauge to a PC or a mobile phone and new **ElcoMaster Software™**
- ***PSPC Ready:*** 90/10 rule with autocheck feature – to meet IMO MSC.215 (82) & MSC.216(82) performance standard for protective coatings in ballast tanks

Can be used in accordance with:

Ferrous (F)		Non-Ferrous (NF)		Dual Ferrous (F) & Non-Ferrous (NF)
ISO 2178	BS 5411-11	ISO 2360	BS 5411-3	All of the Ferrous and Non-Ferrous List plus; ASTM E 376
ISO 2808-6Aa	BS 3900-C5-6Aa	ISO 2808-6Ba	BS 3900-C5-6Ba	
ISO 19840	BS EN ISO 1461	ASTM D 1400	BS 5599	
ASTM B 499	DIN 50981	ASTM B 244	DIN 50984	**All Elcometer 456[3] Models**
ASTM D 1186	SSPC-PA2			IMO MSC.215 (82)
ASTM D 7091				IMO MSC.216 (82)

Coating Thickness Gauges - Digital

Simple to interpret, small and portable gauges for the measurement of coatings on all metal surfaces. Digital coating thickness gauges are more accurate, more repeatable and more reproducible than any other type of coating thickness gauge on the market today.

Elcometer offers the world's most comprehensive range of portable digital coating thickness gauges - for measurements on either Ferrous substrates (F), Non-Ferrous substrates (NF), or on both Ferrous and Non-Ferrous (FNF), Elcometer can provide you with a gauge to meet your need.

With a wide choice of gauges to choose from, the User needs to understand the terminology of Coating Thickness Gauges or, '*The Language of Coatings*'.

The Language of Coatings

In selecting the most appropriate gauge for your application, you need to answer specific questions.

1. **What is the substrate (the surface metal) you are coating/inspecting?**

   Is the metal a Ferrous Substrate (F) or a Non-Ferrous (NF)?
   Sometimes this is difficult to answer – the substrate may have already been coated .The easiest way to identify this is to see if a magnet will stick to the surface. If it does, then the substrate will be Ferrous, if it does not, then the substrate is Non-Ferrous.

2. **Do you measure only on this substrate?**

   If you only inspect one type of product, then the answer is yes. If you have a range of products that you inspect, then you need to consider whether they are all of the same type of substrate. You should also consider if you have a future possibility of inspecting other substrates. If so, you should consider a Dual FNF gauge.

3. **Typically what sort of coating thickness do you need to measure?**

   This helps you select the correct scale range - Scale 1 measures coatings to 1500µm, Scale 2 : 5mm, Scale 3 : 13mm

4. **What type of probe do you need?**

   Depending on your application you can select from:
   - Integral Probe (the probe is built into the gauge for accurate single handed measurements on large surface areas, pipes, etc.)
   - Separate Probe (the probe is connected to the gauge by a cable for all applications).
   - PINIP™ (separate probe is directly attached to the base of the instrument – providing, in your separate gauge, all the benefits of an integral unit).

   Separate Probes can be selected from our wide range to meet your application requirements. These include:
   - *Regular Probes*: Including Straight, Right Angle (90°) and Telescopic options
   - *Miniature Probes:* Including Straight, Right Angle (90°), 45° Angle all in either long or short versions.

5. **Do you need to save your readings for your ISO records, or as proof of inspection to your customer?**

   Elcometer gauges are available in three options:
   - *Basic Gauge* - with simple statistics, links via infrared to a Printer but no memory or data output
   - *Standard Gauge* - with statistics, links via infrared to a Printer, limited memory (250 readings) and data output
   - *Top Gauge* - with statistics, links via infrared to a Printer, enhanced memory (40,000 readings), batching capability and data output.

Measurement Options

Ferrous (F) operation using electromagnetic induction probes for all non-magnetic coatings on a ferrous (magnetic) substrate, e.g. paint, plastic, enamel, powder, rubber, ceramic, galvanising, zinc, sprayed metal (aluminium or zinc), etc. on steel, cast iron, ferritic and duplex stainless steel, substrates etc.

Non-Ferrous (N) operation using eddy current probes for non-conductive coatings on non-ferrous metal substrates, e.g. anodising, paint, powder, lacquer, plastic, etc. on aluminium, brass, zinc, stainless steel, copper, titanium substrates etc.

Dual (FNF) operation combines the Ferrous and Non-Ferrous operation in a single probe. The gauge has user selection for auto or manual substrate determination.

Shipping List

Basic : Unit, Pouch, Calibration Certificate, Calibration Foils - 4 x 2% NBS Foils, Batteries, Wrist Cord, Instructions
Standard : Same as Basic Unit plus : Software CD (ElcoMaster and EDTS+)
Top : Same as Basic Unit plus : Software CD (ElcoMaster and EDTS+)

Elcometer 456 Gauge Features - Technical superiority in the palm of your hand

The 456, whilst easy to use, is packed with features, making it possibly the best coating thickness gauge in the world.

Features	***456 Basic***	***456 Std***	***456 Top***
Fast, accurate reading rate >60 readings per minute	•	•	•
Auto substrate recognition on FNF models	•	•	•
Integral and separate probe models available	•	•	•
Backlight – user selectable ideal for dark environments	•	•	•
Bleeper	•	•	•
Intuitive menu driven display with adjustable text size	•	•	•
Large easy to read Maximised gauge reading display	•	•	•
Languages – menus in 26 languages	•	•	•
User definable limits – *Green / Red LEDs for Pass / Fail Inspection*	•	•	•
User definable on-screen statistics *(from single readings or within batches)*	•	•	•
(No. of readings, Mean, Hi / Lo readings, Std Deviation & Co-efficient of Variation)	•	•	•
Fully Interchangeable Separate Probe Options – *incl Miniature*	•	•	•
On-screen Calibration Instructions / Help function	•	•	•
User switchable Normal / Extended menu options	•	•	•
Calibration options (stated):	•	•	•
- smooth, 2 point, rough surfaces & special substrate	•	•	•
- zero offset† (subtracts a fixed value from reading)*	•	•	•
- ISO, SSPC, Swedish and Australian predefined		•	•
90/10 rule with autocheck feature – to meet IMO MSC.215 (82) & MSC.216(82) performance standard for protective coatings in ballast tanks	•	•	•
Memory			
Readings Memory		250 in one batch	40000 in up to 999 batches
Individual reading mode		•	•
Average and Counted Average		•	•
Individual Reading Review		•	•
Date and time stamp with clock and alarm functions – *readings can be stamped including the last calibration date and time*			•
Batch calibrations – each batch can be programmed with a different calibration			•
Batch calibration cloning – copy calibrations between batches			•
Data Output			
RS232	•	•	•
Available with Bluetooth® wireless technology		•	•
Immediate output mode – each reading is transmitted as it is taken	•	•	•
Batch output mode – send data by batches on command		•	•
Free PC software – ElcoMaster™ & ElcoMaster™ Mobile		•	•

* Zero Offset, USA patent Number 6243661 †Zero offset subtracts a user defined value from the reading. Ideal for ISO 19840

Elcometer 456 Gauge Technical Specifications

Measurement Speed :	Greater than 60 readings per minute
Accuracy :	+/- 1 to 2% using two point Calibration (3% Full Scale)
Display :	STN Graphics (LCD), 128 x 64 pixels; 19.8 x 39.6mm
Battery Type :	2 x AAA (LR03) Rechargeable batteries can be used
Battery Life :	30 - 40 hours continuous use with alkaline dry batteries. (15,000 - 20,000 readings at an average of 8 readings per minute).
Minimum Substrate Thickness :	Ferrous: 0.3mm; Non-Ferrous: 0.1mm unless special calibration adjustment is made
Measurement Options :	Ferrous (F), Non Ferrous (NF) and Dual (FNF)
Operating Temperature :	0 - 50°C
Dimensions :	128 x 68 x 28mm
Weight (incl. Dry Batteries) :	130g

The Elcometer 456 Integral (built in) Probes offer an ideal gauge for flat or uneven surfaces alike. The large 'Bigfoot™ probe allows for consistent and repeatable results as there is no cable, the gauge can take readings using one hand.

The Elcometer 456 Integral Gauges are ideal for measurement on both organic and inorganic coatings and are available in either:

- Ferrous (F),
- Non-Ferrous (NF), or
- Both Ferrous and Non-Ferrous (FNF)

Features of the Elcometer 456 Integral Gauges

- Single handed operation.
- Wide footprint to give greater stability, accuracy & repeatability of readings.
- Ideal for flat & curved surfaces.
- Can be used on smooth & blast profiled substrates.
- Wide range of thickness scales available.

Elcometer 456 Integral Gauge - Specifications and Part Numbers

Substrate	*Model*	*Probe*		*Scale*	*Part Number*
Ferrous	Basic Model	Integral	Ferrous Basic Integral Scale 1	0 - 1500 mic	A456**FBI**1
Ferrous	Basic Model	Integral	Ferrous Basic Integral Scale 12 - High Resolution	0 - 5 mm	A456**FBI**12
Ferrous	Basic Model	Integral	Ferrous Basic Integral Scale 3	0 - 13 mm	A456**FBI**3
Non Ferrous	Basic Model	Integral	Non Ferrous Basic Integral Scale 1	0 - 1500 mic	A456**NBI**1
Both F & NF	Basic Model	Integral	Dual Basic Integral Scale 1	0 - 1500 mic	A456**FNFBI**1
Ferrous	Standard Model	Integral	Ferrous Standard Integral Scale 1	0 - 1500 mic	A456**FSI**1
Ferrous	Standard Model	Integral	Ferrous Standard Integral Scale 12 - High Resolution	0 - 5 mm	A456**FSI**12
Ferrous	Standard Model	Integral	Ferrous Standard Integral Scale 3	0 - 13 mm	A456**FSI**3
Non Ferrous	Standard Model	Integral	Non Ferrous Standard Integral Scale 1	0 - 1500 mic	A456**NSI**1
Both F & NF	Standard Model	Integral	Dual Standard Integral Scale 1	0 - 1500 mic	A456**FNFSI**1
Ferrous	Top Model	Integral	Ferrous Top Integral Scale 1	0 - 1500 mic	A456**FTI**1
Ferrous	Top Model	Integral	Ferrous Top Integral Scale 12 - High Resolution	0 - 5 mm	A456**FTI**12
Ferrous	Top Model	Integral	Ferrous Top Integral Scale 3	0 - 13 mm	A456**FTI**3
Non Ferrous	Top Model	Integral	Non Ferrous Top Integral Scale 1	0 - 1500 mic	A456**NTI**1
Both F & NF	Top Model	Integral	Dual Top Integral Scale 1	0 - 1500 mic	A456**FNFTI**1

The F1 2 Scale combines the F1 Scale and F2 Scale in a single probe (Patent applied for) with the user selecting the appropriate range (and hence resolution) for the work in hand. Resolution similar to Scale 1 for 0 – 1500 mic range and similar to Scale 2 for 1500 mic to 5 mm range.

Elcometer 456 Separate Gauge

The Elcometer 456 Separate (Plug in) Probe Option is the most versatile gauge for the measurement of a wide range of coatings on metal substrates.

- Available in Basic, Standard and Top Models.
- Available in Ferrous (F), Non-Ferrous (NF) & Dual FNF versions.

Features of the Elcometer 456 Separate (Plug in) Probe Option

- A wide range of probes available for measurements in almost any environment.
- Fully interchangeable probes:
- All Ferrous models will accept ANY Ferrous 456 probe
- All Non-Ferrous models will accept ANY Non-Ferrous 456probe
- All Dual FNF models will accept ALL 456 probes
- Ideal for measuring coating thickness in small & large, smooth & curved, open air or confined environments.

Elcometer 456 Separate Gauge - Specifications and Part Numbers

Substrate	Model	Probe	Description
Ferrous	Basic Model	Separate	Ferrous Basic Integral Scale 1
Ferrous	Basic Model	Separate	Ferrous Basic Integral Scale 12 - High Resolution
Ferrous	Basic Model	Separate	Ferrous Basic Integral Scale 3
Non Ferrous	Basic Model	Separate	Non Ferrous Basic Integral Scale 1
Both F & NF	Basic Model	Separate	Dual Basic Integral Scale 1
Ferrous	Standard Model	Separate	Ferrous Standard Integral Scale 1
Ferrous	Standard Model	Separate	Ferrous Standard Integral Scale 12 - High Resolution
Ferrous	Standard Model	Separate	Ferrous Standard Integral Scale 3
Non Ferrous	Standard Model	Separate	Non Ferrous Standard Integral Scale 1
Both F & NF	Standard Model	Separate	Dual Standard Integral Scale 1
Ferrous	Top Model	Separate	Ferrous Top Integral Scale 1
Ferrous	Top Model	Separate	Ferrous Top Integral Scale 12 - High Resolution
Ferrous	Top Model	Separate	Ferrous Top Integral Scale 3
Non Ferrous	Top Model	Separate	Non Ferrous Top Integral Scale 1
Both F & NF	Top Model	Separate	Dual Top Integral Scale 1

The above Part Numbers include the Standard Probes. For further options of separate probes see the Elcometer 456 Probe Option leaflet.

Separate Probe Types

A wide range of probe types and scale ranges are available for the Elcometer 456 separate gauge.

Standard Probes (F, NF & FNF)
Available in Standard, Right Angle or Telescopic options and are suitable for most coating thickness requirements.

Miniature Probes (F & NF)
Ideal for taking measurements in hard to reach places, on small surface areas and on concrete reinforcement bars. Miniature probes are available in Straight, Right Angle and 45° options. All miniature probes are available in either 45mm or 150mm probe lengths.

PINIP™ Probes (F, NF & FNF)
The Plug-In Integral Probe (PINIP™), has been designed to be screwed into the base of any separate Elcometer 456 gauge to transform their separate gauge into an integral unit for single handed operations. Its 'Bigfoot™' Probe gives greater stability on large surface areas.
Also available is a High Temperature version for measuring coatings on hot ferrous substrates up to 250°C

Waterproof Probes (F)
Ideal for taking measurements in wet conditions or underwater up to depths of 10m. Waterproof probes are available with standard, 5m and 15m probe lead lengths.

Major Users of the 456 and the superceded 345 :

CSIR & SABS • SA Navy • Defence Force & Armscor • SA Navy • Denel • Naschem • Sonchem • ALL MAJOR Motor Assemblers incl. Daimler Benz • Nissan • Ford / Mazda • BMW • Toyota • VW etc • MAJOR Industrial Painters eg. RJ Southey • Gordon Bennett etc • Paint Manufacturers : Plascon • Dulux • Dekro etc • Corrosion Consultants / Inspectors • Anodisers incl Huletts • Portnet • Spoornet & SATS • Transwerk & Transnet • ESKOM • ISCOR • Public Works • SASOL & Mossgas • Shell, BP & Caltex Refineries • Anglo American & Vaal Mines & Others • Telkom • SA Airways & Atlas • Atomic Energy Board • Water Boards • Dept Water Affairs • Dorbyl & Heavy Engin • Universities • Govt & Municpal Authorities • Powder Coaters • Pipeline Co's • Sand / Shot Blasters • Metal Fabricators • Galvanisers • Shipbuilders

Appendix I: Daily Log for Work on Fuel Tank Piping

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/02/09 JOB # 3820 OBSERVATION NO. 26

CUSTOMER MANDARGE INSPECTOR Adam Brown TIME ARRIVED 8AM TIME LEFT 5pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 5

FOREMAN Ben Eborn CONTRACTOR JFW of N.C.

WEATHER CONDITIONS:

SUNNY CLOUDY (RAIN) SNOW WIND 5-10 MPH FROM SE

LAST NIGHT: LOW TEMP 27°F THIS MORNING HUMIDITY 60 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
			N/A			

INTERIOR: CREW worked on cleaning up the DUST of spent abrasive around fuel tank #2

EXTERIOR: Final DFT on large fuel tank is as follows: min. 10 mils
max. 14 mils
AVEG. 12 mils

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
					N/A					

APPLICATION METHODS: N/A

REMARKS: Paint Storage at 65°F

MIL GAUGE SERIAL NUMBER (1) N/A Elco 456 FG0054 CALIBRATED – BEFORE (2) N/A ✓ AFTER (3) N/A ✓

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/02/09 JOB # 3820 OBSERVATION NO. 27

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 7am TIME LEFT 5pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 5

FOREMAN BEN EBORN CONTRACTOR J+W of NC

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND calm MPH FROM E

LAST NIGHT: LOW TEMP 40°F THIS MORNING HUMIDITY 100 %

TIME PAINTING: START 9am FINISH 10:30am INT N/A EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
7am	N/A	68°F	55°F	N/A	68%	45°F
9:45am	N/A	68°F	68°F	N/A	49%	41°F
11am	N/A	75°F	70°F	N/A	28%	44°F
2pm	N/A	65°F	62°F	N/A	47%	42°F
3pm	N/A	75°F	67°F	N/A	39%	41°F

INTERIOR: 3 MEN blasted in 3 SEPARATE PIPE containment tents - East tent, middle tent, and West tent. All surfaces blasted in accordance to SSPC-SP10 and verified with SSPC-VIS1 and test panel. All surfaces clean and free of oil or grease. Blotter test indicated no oil or moisture in air. chlor-test indicated 0 solvable salt contamination

EXTERIOR: on blasted surfaces. Testex tape indicated A surface profile of 2.8mils. approx. 5% of surfaces in west tent were missed blast. Suggested to foreman these areas be re blasted to meet SSPC-SP10 before priming. Foreman agreed and complied. Test Panels 1-36 blasted in conjunction with pipes. Test panels 1-24 primed in conjuction with pipes

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT MIN	MAX	AVG
pipes E, middle, and W tents	Tesla Nano Coatings Teslan ZN PRIMER	08001	TYPE II	8%	114460	DARK GREY	4 gal	n/a	n/a	n/a

APPLICATION METHODS: 2 parts separately power mixed then combined 1 part A & with 2 parts B and thinner then power mixed. Airless spray at 3000 PSI using .021" tip orifice. Prime under constant agitation during application.

REMARKS: Paint storage at 70°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/04/09 JOB # 3820 OBSERVATION NO. 28

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 11am

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 5

FOREMAN BEN EBORN CONTRACTOR J+W of NC

WEATHER CONDITIONS:

SUNNY (CLOUDY) (RAIN) SNOW WIND calm MPH FROM SW

LAST NIGHT: LOW TEMP 41°F THIS MORNING HUMIDITY 95 %

TIME PAINTING: START 8:30am FINISH 9:30am INT N/A EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8:30am	N/A	70°F	64°F	N/A	83%	59°F
7am	N/A	66°F	62°F	N/A	64%	50°F
9:30am	N/A	76°F	69°F	N/A	57%	53°F

INTERIOR: Two men applied stripe coat to all pipes in East, middle and West containment tents. Crew worked on cleaning up spent blast debris around large fuel tank.

EXTERIOR:

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT MIN	MAX	AVG
East, middle and West containment tents	Tesla Nano Coatings Teslan Epoxy Polyamide	002	N/A	NONE	N/A	white	6 1 gal	2mils	5mils	3mils

APPLICATION METHODS: 2 equal parts of A and B power mixed separately then combined and power mixed. Applied by Brush

REMARKS: Paint storage at 70° F

MIL GAUGE SERIAL NUMBER Elco 456 FB0054 CALIBRATED – BEFORE ✓ AFTER ✓

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/05/09 JOB # 3820 OBSERVATION NO. 29

CUSTOMER Mandaree INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 5:30 pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 5

FOREMAN Ben Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

SUNNY CLOUDY RAIN SNOW WIND 5-10 MPH FROM SW

LAST NIGHT: LOW TEMP 50°F THIS MORNING HUMIDITY 100 %

TIME PAINTING: START 9am FINISH 10:30am INT N/A EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8:30am	N/A	67°F	63°F	N/A	80%	57°F
9:00am	N/A	89°F	87°F	N/A	34%	56°F
11:00am	N/A	80°F	78°F	N/A	50%	59°F
1 Pm	N/A	71°F	69°F	N/A	69%	58°F
3 Pm	N/A	80°F	67°F	N/A	71%	59°F

INTERIOR: Crew worked on cleaning up and hawling off spent abrasive, one man sprayed intermediate coat on all pipes in containment tents East, middle and west. All surfaces painted are clean and free of any oil or greese Chlor-Tests indicated 0 soluable salt contamination. 3 holidays observed in East Tent. Suggested

EXTERIOR: to Forman to touch up today. He agreed. One man touched up holidays with Brush. Test panels 35-36 sprayed with intermediate in conjunction with pipes.

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
East, middle and west containment Tents	Tesla Nano coatings Teslan Epoxy Polyamide	002	N/A	NONE	N/A	white	5 gal	2mils	5mils	3mils

APPLICATION METHODS: Equal parts of A and B power mixed separately then combined and power mixed. Airless spray at 3600 psi with .017" tip orifice.

REMARKS: paint storage at 70°F

MIL GAUGE SERIAL NUMBER Elco 456 CALIBRATED – BEFORE ✓ AFTER ✓

FC 0054

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/06/09 JOB # 3820 OBSERVATION NO. 30

CUSTOMER Mandaree INSPECTOR Adam Brown TIME ARRIVED 9am TIME LEFT 11Am

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN Ben Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

SUNNY CLOUDY (RAIN) SNOW WIND 5-10 MPH FROM NE

LAST NIGHT: LOW TEMP 51°F THIS MORNING HUMIDITY 95 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8:30am	N/A	71°F	64°F	N/A	92%	62°F
10 Am	N/A	72°F	66°F	N/A	84%	62°F
11Am	N/A	78°F	76°F	N/A	66%	64°F

INTERIOR: Intermediate cured dry hard. No painting today due to RAIN. Crew finished clean up and hawling off spent abrasive from large fuel tank.

EXTERIOR:

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
				N/A						

APPLICATION METHODS: N/A

REMARKS: Paint storage at 70°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/08/09 JOB # 3820 OBSERVATION NO. 31

CUSTOMER MANCHREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 2:30 Pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN BEN EBORN CONTRACTOR J+W of NC

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8Am	N/A	62°F	62°F	N/A	40%	38°F
9am	N/A	61°F	60°F	N/A	39%	37°F
11Am	N/A	70°F	68°F	N/A	35%	40°F
12:30Pm	N/A	81°F	64°F	N/A	36%	37°F

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND SW 10-15 MPH FROM SW

LAST NIGHT: LOW TEMP 35°F THIS MORNING HUMIDITY 50 %

TIME PAINTING: START 9Am FINISH 11:30 INT N/A EXT ✓

INTERIOR: No work yesterday due to RAIN. One man sprayed Finish coat on all pipes in East, middle and west containment Tents. All surfaces painted are clean and free of any oil or grease. Chlor-Tests indicated no solvable salt contamination. Test Panels 25-36 sprayed with Finish coat in conjunction with pipes

EXTERIOR: one man Applied Sikaflex 1a, product code 431-241, between concrete Foundation and tank base plate on the West, large fuel tank.

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
East, middle and West containment tents	TEsla Nano Coatings Tesian Urethane Topcoat	6003	N/A	None	N/A	Desert Tan	7 gal	5 mils	8 mils	6 mils

APPLICATION METHODS: Parts A and B Power mixed separately then combined 3 Parts A with 1 Part B and Power mixed. Airless spray at 2700 psi with .015 tip orifice.

REMARKS: Paint storage at 60°F

MIL GAUGE SERIAL NUMBER Elco 456 CALIBRATED – BEFORE ✓ AFTER ✓

F66054

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/09/09 JOB # 3820 OBSERVATION NO. 32

CUSTOMER MANCHREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 3

FOREMAN BEN EBORN CONTRACTOR J+W of N.C.

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8Am	N/A	67°F	55°F	N/A	30%	24°F

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND S-10 MPH FROM W

LAST NIGHT: LOW TEMP 30°F THIS MORNING HUMIDITY 52 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

INTERIOR: Finish coat cure this morning. Crew worked on takeing down Phase 1 containment of pipes and set up Phase 2 containment for pipes.

EXTERIOR:

~~LOCATION~~	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG

APPLICATION METHODS: N/A

REMARKS: Paint storage at 65°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/10/09 JOB # 3820 OBSERVATION NO. 33

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 5pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN BEN Eborn CONTRACTOR J+W of N.C.

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND 15-20 MPH FROM SW

LAST NIGHT: LOW TEMP 29°F THIS MORNING HUMIDITY 80 %

TIME PAINTING: START n/a FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8Am	N/A	80°F	76°F	n/a	25%	39°F
10Am	N/A	65°F	60°F	N/A	40%	36°F
1:30Pm	N/A	76°F	71°F	N/A	42%	47°F

INTERIOR: 3 men worked on Blasting Phase II of pipes – N wall tent and SW corner tent. Due to a Forcast of Rain tonight Foreman chose not to prime out. Reblasted panels 25-36.

EXTERIOR:

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG

APPLICATION METHODS: N/A

REMARKS: paint storage At 65°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/11/09 JOB # 3820 OBSERVATION NO. 34

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8Am TIME LEFT 5pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN BEN Eborn CONTRACTOR J+W of NC.

WEATHER CONDITIONS:

(SUNNY) (CLOUDY) RAIN SNOW WIND 5-10 MPH FROM NW

LAST NIGHT: LOW TEMP 45°F THIS MORNING HUMIDITY 100 %

TIME PAINTING: START 10Am FINISH NOON INT EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
9Am	N/A	72°F	70°F	N/A	56%	54°F
10:00Am	N/A	65°F	63°F	N/A	74%	55°F
11Am	N/A	66°F	69°F	N/A	55%	52°F
2:30Pm	N/A	70°F	65°F	N/A	50%	45°F

INTERIOR: Due to Rain last night Phase II pipes had to be RE blasted. All surfaces painted in accordance to SSPC-SP 10 and varified with SSPC-Vis 1 and test panel. All surfaces clean and free of oil and grease (see Remarks) and chlor-tests indicated 0 soluable salt contamination. Panels 1-24 sprayed with

EXTERIOR: Additional primer due to low DFTs. Testex tape indicated a 2.8 mil blast profile

LOCATION Phase II	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
N wall	Tesla Nano Coatings									
N wall	Teslan ZN Primer	09001	Type II	3%	114460	Dark Grey	7 gal	n/a	n/a	n/a
SW corner										

APPLICATION METHODS: 1 part A and 2 parts B power mixed separately then combined and thinner added and power mixed. Constant agitation during application. Airless sprayed at 2200 psi with .015" tip orifice. Brush and

REMARKS: Roll also. Fuel leak on West Flange of large West fuel tank. Paint storage at 65°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/12/09 JOB # 3820 OBSERVATION NO. 35

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 5 Pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN BEN Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND 5-10 MPH FROM NW

LAST NIGHT: LOW TEMP 42°F THIS MORNING HUMIDITY 85 %

TIME PAINTING: START 9am FINISH 1pm INT ___ EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8Am	N/A	56°F	55°F	N/A	55%	39°F
9:30am	N/A	67°F	63°F	N/A	33%	33°F
11:Am	N/A	71°F	70°F	N/A	28%	35°F
2 Pm	N/A	68°F	66°F	N/A	28%	32°F
4 Pm	N/A	78°F	70°F	N/A	23%	32°F

INTERIOR: CREW worked on application of INTERMEDIATE coat ON PHASE II of pipes. All surfaces painted are clean and free of any oil or greese. SEE REMARKS ON 01/11/09 REPORT. Chloride tests indicated 0 soluable salt contamination. CURE test indicated primer was cure to

EXTERIOR: RECOAT. Test panels 25-36 hand tool cleaned in accordance to SSPC-SP11. All panels sprayed with INTERMEDIATE coAt

LOCATION Phase II	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
N WALL	TESLA NANO COATINGS	002	N/A	NONE	N/A	white	10 gal	2mils	5mils	3mils
W WALL	TESLAN EPOXY POLYAMIDE									
SW CORNER										

APPLICATION METHODS: 2 EQUAL PARTS OF A AND B POWER MIXED SEPARATLY THEN combined AND POWER MIXED. AIRLESS SPRAYED AT 3200 PSI AND BRUSH AND Rolled. .017" tip ORIFICE.

REMARKS: PAINT STORAGE AT 65°F

MIL GAUGE SERIAL NUMBER Elco 456 CALIBRATED – BEFORE ✓ AFTER ✓

FG 0054

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/13/09 JOB # 3820 OBSERVATION NO. 36

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8Am TIME LEFT 2Pm

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN BEN Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

SUNNY CLOUDY RAIN SNOW WIND 5 MPH FROM NE

LAST NIGHT: LOW TEMP 28°F THIS MORNING HUMIDITY 90 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8 Am	N/A	67°F	63°F	N/A	37%	37°F
NOON	N/A	60°F	51°F	N/A	57%	36°F

INTERIOR: INTERMEDIATE coAt ON PHASE II of pipes Not CURED. NO PAINTING today

EXTERIOR: CREW WORKED ON CLEAN UP

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG

APPLICATION METHODS: N/A

REMARKS: PAINT STORAGE AT 65°F

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/14/09 JOB # 3820 OBSERVATION NO. 37

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 5pm

LOCATION Fort Bragg, NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN Ben Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND 5-10 MPH FROM NW

LAST NIGHT: LOW TEMP 30°F THIS MORNING HUMIDITY 65 %

TIME PAINTING: START 8am FINISH 1 Pm INT N/A EXT ✓

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8 Am	N/A	60°F	50°F	N/A	41%	27°F
10:30am	N/A	61°F	67°F	N/A	21%	27°F
1 Pm	N/A	71°F	68°F	N/A	16%	21°F
1:30Pm	N/A	76°F	61°F	N/A	19%	20°F
3 Pm	N/A	59°F	60°F	N/A	23%	23°F

INTERIOR: CURE TEST INDICATED INTERMEDIATE COAT WAS CURE TO RECOAT. ALL SURFACES PAINTED ARE CLEAN AND FREE OF OIL AND GREESE. (SEE REMARKS ON 01/11/09) CHLOR-TESTS INDICATED 0 SOLUBLE SALT CONTAMINATION. 2 MEN WORKING IN NORTH WALL TENT AND 2 MEN WORKING IN WEST AND SW CORNER TENT APPLYING FINISH COAT TO PHASE II PIPES.

EXTERIOR: PANELS 1-12 AND 25-36 SPRAYED WITH FINISH COAT IN CONJUNCTION WITH APPLICATION OF FINISH ON PHASE II PIPES

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT MIN	MAX	AVG
Phase II Pipes	TEMA NANO Coatings									
N WALL	TEMAN URETHANE TOPCOAT	003	N/A	NONE	N/A	DESERT TAN	5 GAL	10mils	13mils	11.5mils
W WALL										
SW CORNER										

APPLICATION METHODS: PARTS A AND B POWER MIXED SEPARATELY THEN COMBINED 3 PARTS A WITH 1 PART B AND POWER MIXED. BRUSH ROLL AND AIRLESS SPRAYED AT 2700 PSI WITH .015" TIP ORIFICE.

REMARKS:

Paint Storage at 60°F

MIL GAUGE SERIAL NUMBER Elco 456 FG0054 CALIBRATED – BEFORE ✓ AFTER ✓

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/15/09 JOB # 3820 OBSERVATION NO. 38

CUSTOMER MANDAREE INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 6:30 pm

LOCATION Fort Bragg, NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN Ben Eborn CONTRACTOR J+W of NC

WEATHER CONDITIONS:

(SUNNY) CLOUDY RAIN SNOW WIND 5-10 MPH FROM NW

LAST NIGHT: LOW TEMP 29°F THIS MORNING HUMIDITY 50 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL. HUM.	DEW POINT
8AM	N/A	58°F	52°F	N/A	43%	31°F

INTERIOR: CURE TEST INDICATED PHASE II PIPES FINISH COAT WAS CURE, dry hard. CREW worked on demobilization

EXTERIOR: FINAL DFT's ON ALL PIPES ARE AS follows: MIN 11mils, MAX 14 mils, AVE 13mils
FINAL DFTS ON small horizontal TANK ARE: MIN 7mils, MAX 15mils AVE 10mils
FINAL DFTS ON LARGE horizontal TANK ARE: MIN 5mils, MAX 16mils AVE 10mils

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT MIN	MAX	AVG
					N/A					

APPLICATION METHODS: N/A

REMARKS: Paint Storage at 60°F. Surplus paint Picked up By manufacture

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

WORK IN PROGRESS OBSERVATION – DAILY FORM DATE 01/16/09 JOB # 3820 OBSERVATION NO. 39

CUSTOMER Mandaree INSPECTOR Adam Brown TIME ARRIVED 8am TIME LEFT 11 Am

LOCATION Fort Bragg NC OWNER Fort Bragg # OF CREW MEMBERS ON JOB 4

FOREMAN Ben Eborn CONTRACTOR J & W of NC

WEATHER CONDITIONS:

SUNNY CLOUDY RAIN SNOW WIND 10-15 MPH FROM N

LAST NIGHT: LOW TEMP 19°F THIS MORNING HUMIDITY 30 %

TIME PAINTING: START N/A FINISH N/A INT N/A EXT N/A

TIME	STEEL SUN	STEEL SHADE	DRY BULB	WET BULB	REL HUM.	DEW POINT
			N/A			

INTERIOR: Crew finish loading and demobilized. Punch list includes: caulk east fuel tank base plate, remove safty rope from top of west tank, minor finish coat touch up on pipes, install decals on all

EXTERIOR: 4 tanks in secondary containment, and install all conduit brackets next to piping. Contractor said they will come back at a later date to finish punch list when environmental conditions are more suitable.

LOCATION	PAINT MANUFACTURER & SERIES NUMBER	BATCH NUMBER	THINNER TYPE	% THINNER	THINNER BATCH #	PAINT COLOR	QUANTITY	DFT BEFORE THIS COAT		
								MIN	MAX	AVG
					N/A					

APPLICATION METHODS: N/A

REMARKS: NONE

MIL GAUGE SERIAL NUMBER N/A CALIBRATED – BEFORE N/A AFTER N/A

Appendix J: Quarterly Coating Assessments

All assessments occurred at 3, 6, 9, and 12 months. Test panels were evaluated according to ASTM D 1654 Procedure A, Method 2 and Procedure B. The coating on the tank itself was evaluated using ASTM D 1654 Procedures B and D. A total of six coupons were tested, four were coated with the zinc-rich primer, intermediate primer and a topcoat and two were coated with the zinc-rich primer, intermediate primer but without a topcoat. When the coupons were dry, each was scribed using a steel thread cutting lathe tool bit with a cutting tip having a 60 degree angle. The tool bit was mounted to a metal handle to facilitate the scribing of a 7 inch vertical line into each coupon. They were then mounted to a rack and were exposed to the elements for the past 12 months with monitoring and photography occurring every quarter.

A damp cloth was used to wipe the coupons before any examinations were conducted. Each of the six coupons was visually inspected for rust and blisters in accordance with ASTM D 174 and ASTM D 610. The surface area percentage of rust per coupon in the scribe was determined using visual examples in Figure 1 of ASTM D 610. Visual examples from Figures 1-4 of ASTM D 714 were also used to establish a qualitative term that was given to represent the frequency, if any were present.

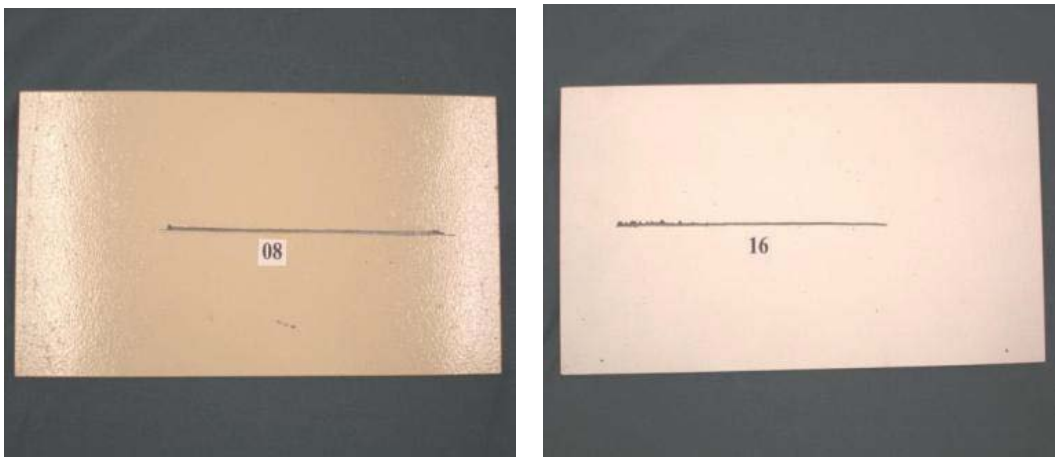
In order to determine the corrosive performance of the coupons, the coupons were subjected to scraping through the use of a rigid spatula placed perpendicular to the coupon surface. The coupon was placed under a gentle stream of water that was no more than 45 °C or (110 °F). The amount of time for each scrape did not exceed 3 minutes. The coupons were then dried using paper towels followed by examining them for creep.

All of the data has been summarized and represented in the table below. The evaluations of the coupons were assessed using a rating number with 10 representing no presence of corrosion and zero meaning a high amount of a specific corrosive property.

Table N1. Material evaluation results per ASTM D 1654 and ASTM D 610.

Coupon ID	Blister	Rust-Unscribed Area	Creep
First Quarter			
08	10-None	10	10
11	10-None	10	10
16	10-None	10	10
22	10-None	10	10
26	10-None	10	10
35	10-None	10	10
Second Quarter			
08	10-None	10	10
11	10-None	10	10
16	10-None	10	10
22	10-None	10	10
26	10-None	10	10
35	10-None	10	10
Third Quarter			
08	10-None	10	10
11	10-None	10	10
16	10-None	10	10
22	10-None	10	10
26	10-None	10	10
35	10-None	10	10
Fourth Quarter			
08	10-None	10	10
11	10-None	10	10
16	10-None	10	10
22	10-None	10	10
26	10-None	10	10
35	10-None	10	10

Coupon documentation



Initial

First quarter

Second quarter


Third Quarter


Fourth quarter

Tank documentation

First Quarter

Second Quarter

Third Quarter

Fourth Quarter

Pipe documentation

First Quarter

Second Quarter

Third Quarter

Fourth Quarter

The numerical ratings, photographic documentation and on-site evaluation can provide technical insight to the overall performance of the coat-

ing. There were no signs of any blistering, topcoat lifting, or creep extending from the scribe mark, for the entire course of the exposure period, on any part of the coating system. There were signs of paint cracking during the scribing process due to the brittle coating system on the intermediate primer coupons (16 and 22) as well as coupon 11. Mildew has formed on the intermediate primer coupons because there was no topcoat present to protect the coupons. During the evaluations of the coupons it was noted that the scribe marks formed rust rapidly and had completely rusted after the first quarter. The amount of surface oxidation continued to increase with each quarter as seen by the increasing length of the rust tail that was eventually washed out of the scribe causing it to stain the topcoat. This surface oxidation was easily removed by rinsing the coupon. Fuel Tank #2 also showed no signs of detrimental corrosion during the exposure period. The coating is still adhering to the metal surface without any blistering or fading. The coating on the piping is consistent with the performance on the fuel tank. The use of zinc-rich primer as an effective coating system is certainly supported by these assessments, results and pictures.

REPORT DOCUMENTATION PAGE

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5b. GRANT NUMBER

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14. ABSTRACT

Above-ground steel fuel tanks, some as large as 1 million gallons, are the main fuel supply for central energy plants and aviation support throughout the Department of Defense (DoD). These tanks and their associated pipelines are aging and many need remediation before leaks or catastrophic failures occur. This project evaluated an emerging coating technology for steel tanks and implemented the technology at Fort Bragg, NC, on a fuel oil storage tank.

For conventional zinc-rich primer to be effective, the metallic zinc dust pigment particles must be heavily loaded in the coating binder (65–95%) so that zinc particles are in contact with each other for electrical conductivity. This high loading can be problematic during coating application/removal due to zinc metal's heavy weight and the traces of lead it normally contains. The coating used in this project is a technically advanced primer additive that uses galvanically inactive, electrically conductive, single-wall carbon nanotubes in conjunction with a much lower percentage of the metallic zinc powder (~30%) to produce the enhanced galvanic reactivity with the steel substrate. The reduced content of the zinc pigment to resin/binder volume ratio also improves the coating integrity and application.

15. SUBJECT TERMS
corrosion prevention, nanomaterials, zinc coatings, fuel tanks, pipelines, steel structures, Fort Bragg, NC

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